POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

Extension to South Meadow

What Is This Asymmetrical Current?

Operating Data on 2500 lb Twin Branch Station

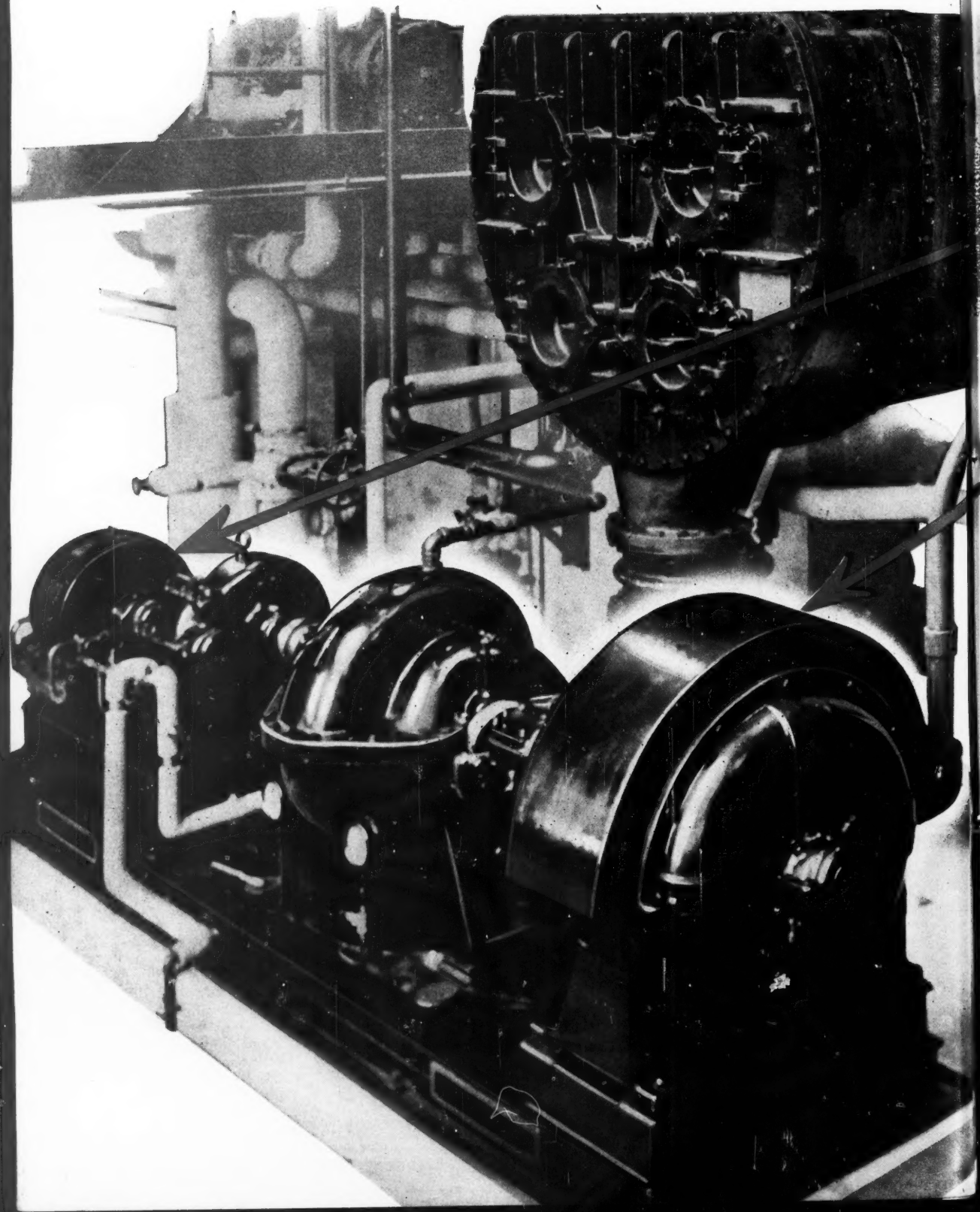
Postwar Plant for Furniture Industry

Spinning Turbines on Power Systems

JANUARY 1944

Turbine or motor f

Tech



for auxiliary drives?

ELLIOTT builds both

Your heat balance may call specifically for motor or turbine drives for various power house auxiliaries, or for dual drives, as illustrated here.

Whatever the drive, its operating qualities must emphasize smooth-running, trouble-free reliability.

That is why Elliott motors and turbines make such acceptable auxiliary drives. For if there is one predominant quality of Elliott engineering it is the practice of building extra performance ability into a machine, putting too much into a turbine or motor rather than to skimp materials and workmanship for a border-line job.

The installation pictured is all-Elliott — the condenser, its ejector, dual drives for both circulating and condensate pumps. (The turbine-generator which the condenser serves is, in this case, also Elliott.) Certainly an instance of unified responsibility. Elliott engineers, knowing all the operating conditions could do a fine coordinating job, resulting in unusually satisfactory and harmonious operation.

But, in any event, Elliott motors and turbines for auxiliary drives can add their extra stamina to the overall dependability factor of your plant.

With a complete line of direct-drive or geared turbines, single-stage or multi-stage, and all types of motors required for power plant auxiliary drive, with an especially fine reputation for two-pole, 3600-rpm units, Elliott has the drive you need.

A star has been added to the Army-Navy "E" flags flown by both the Jeannette and the Ridgway plants of Elliott Company.

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Q-1099

DIESELS OUT IN FRONT!

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Texaco Algol or *Ursa Oils* increase life of rings, pistons, liners and bearings, keep rings free in their grooves, valves active, ports clear, assuring piston seal that means full power and maximum fuel economy.

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More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

Texaco Lubrication Engineering Service is available to you through more than 2300 wholesale distributing points in the 48 States. The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Lubricants and Fuels

FOR ALL DIESEL ENGINES

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

POWER PLANT ENGINEERING

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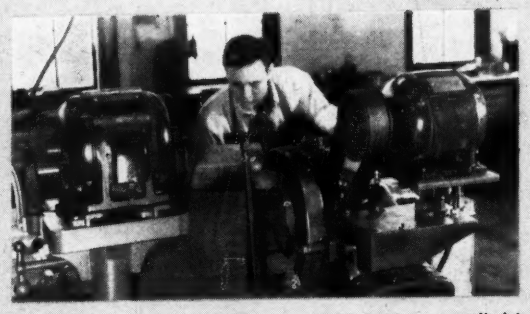
Tech

SHORTS STYMIED

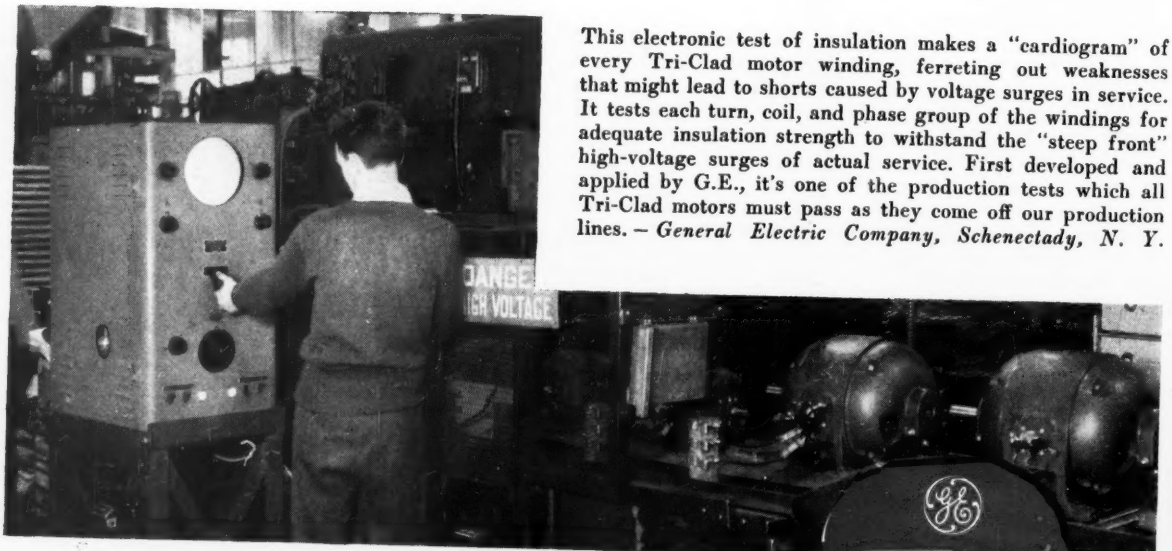
Voltage surges which accompany switching and frequent starting and stopping of motors impose high dielectric stresses on the coil insulation, and can cause harmful short circuits. Yet this is an unavoidable condition of service for many motors.

The grinder shown here, for example, starts and stops every time a finished part is removed and a new part inserted. But the two Tri-Clad motors that drive it have been built to withstand safely the voltage surges ordinarily encountered in this type of service. Their ability to "stymie" shorts was proved by *the new General Electric test* described below.



External grinder, equipped with two Tri-Clad motors, installed in the milk-machinery manufacturing plant of the Rite-Way Products Company, Chicago, Ill.

New high-potential, electronic surge-tester verifies strength of TRI CLAD motor windings



This electronic test of insulation makes a "cardiogram" of every Tri-Clad motor winding, ferreting out weaknesses that might lead to shorts caused by voltage surges in service. It tests each turn, coil, and phase group of the windings for adequate insulation strength to withstand the "steep front" high-voltage surges of actual service. First developed and applied by G.E., it's one of the production tests which all Tri-Clad motors must pass as they come off our production lines. — *General Electric Company, Schenectady, N. Y.*

GENERAL ELECTRIC

Each week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds.

FRONT LINES

ALREADY the problems of employment for the soldier and sailor returning from battle are upon us. It is somewhat startling to learn, from a recent OWI report on training and employment opportunities for discharged servicemen of this war, that up to date at least 800,000 veterans of this war have been given discharges from the Army, Navy and Marine Corps. Of these 370,000 were released from the Army for medical reasons and 46,961 from the Navy and Marine Corps for medical reasons. The remainder have been discharged for a number of reasons, the most important of which is over-age. The report referred to, No. OWI-2758, entitled "Employment and Training of Discharged Veterans", gives many interesting details of the opportunities available to such men and what advantage is being taken of them.

CONTROLLED MATERIALS may now be obtained in specified amounts under CMP Regulation 9A by repairmen, including electricians and electrical appliance servicemen, according to a recent WPB announcement. Such material includes limited amounts of carbon and alloy steel, copper and copper base alloys, brass mill and foundry products, and aluminum. Refrigerator, radio and domestic appliance repairmen, electricians and electrical contractors may buy $150 worth of copper wire each quarter or one-eighth of the amount of copper wire used for repairs in 1941 (figured by dollar volume), whichever is greater. Repairmen may also buy as much other material and repair parts as are needed for repair and maintenance work. Full details are given in the new Regulation 9A which replaces Regulation 9. It can readily be seen that even this slight relaxation of material control will appreciably relieve the burden on many industries.

SEEKING a new source of carbon suitable for making the electrodes required in the production of aluminum, Bureau of Mines chemists have found that mineral impurities in three low-ash domestic coals may be reduced sufficiently by float-and-sink and acid-leaching processes to yield a coke of the desired quality, Dr. R. R. Sayers, Director of the Bureau of Mines, has announced. Calcined petroleum coke now is the standard material for making electrodes for the aluminum industry. Since about three-quarters of a pound of carbon electrode is consumed for each pound of aluminum produced, a substitute material may become necessary in view of the immensely expanded aluminum production. Five of the seven coals tested by the float-and-sink method yielded products with appreciably less than 1.0 per cent ash, but even these contained more mineral impurities than is desirable in electrode carbon. By treating float coals with an acid solution containing 10 per cent hydrochloric and 5 per cent hydrofluoric acid, however, they obtained products with an ash content as low as 0.31 per cent. Acid leaching would be expensive, it was acknowledged. The oil-and-water process for cleaning coal was much less efficient than the float-and-sink method in removing mineral matter. A copy of the report may be obtained by writing to the Bureau of Mines, Department of the Interior, Washington 25, D. C., for Report of Investigation 3731, "Low-Ash Coals of the Appalachian Region as Possible Sources of Coke for Carbon Electrodes for Aluminum Industry" by W. A. Selvig, W. H. Ode, and F. H. Gibon.

AT A RECENT meeting of the advisory committee of the Northwestern University Technological Institute, as reported in the Chicago Sun, Charles F. Kettering, vice-president of General Motors Corp., said: "Despite the present emphasis during the war on the industrial studies, cultural education is not a thing of the past, and the pendulum is bound to swing back to it. That does not mean that technological studies are to be abandoned, but there will be a more healthy ratio of the liberal arts courses." Dr. Robert A. Milliken, world-famous physicist and president of the California Institute of Technology, questioned as to the possibility of the use of atomic power in the future, explained that present machinery and equipment are sufficient to sustain the world for some 20 centuries and atomic power won't be needed much before then. These comments are interesting—to us, at least—in view of our own comments on the same subjects in the Front Lines pages of both the November and December issues.

ONE-SEVENTH of the nation's butadiene supply is expected to come from a new plant at Port Neches, Texas, just going into operation. Here, five of the country's largest coal companies have joined forces to operate for the United States, without profit, the world's largest plant for manufacturing butadiene. The plant, built by Defense Plant Corp., will be operated by Neches Butane Products Co., organized by Atlantic Refining, Gulf Oil, Pure Oil, Socony-Vacuum Oil and the Texas companies. Refinery gases produced in the manufacture of petroleum products will be piped to the new plant from nearby refineries of the five participating companies.

ONE OF THE strangest sights of the present war is the building of relatively large ships way in the middle of this country—in Illinois, Ohio and other states where you wonder how in the world they are ever going to get those ships into the ocean. One of the factors that makes it possible, for which the Navy gives much thanks, is that so many dams built primarily for flood control purposes make it possible to control water levels in many of the tributaries to the Mississippi and in the Mississippi itself. Thus the entire Federal flood control and power development program of the past 10 years turns out to have important military advantages, despite the lip curlings of the haters of "bureauocracy."

BECAUSE HOME OWNERS in the New England and Middle Atlantic States are finding it increasingly difficult to obtain anthracite for fuel, the Bureau of Mines has issued a publication describing how mixtures of anthracite and bituminous coal, or bituminous coal alone, can be utilized satisfactorily in many domestic anthracite heating units this winter, Dr. R. R. Sayers, Bureau Director, has announced. In this new publication, "Supplementing Anthracite with Other Fuels for Home Heating," the Bureau prescribes a mixture of ¾ anthracite and ¼ low-volatile bituminous coal as being the most satisfactory for many home furnaces. The fuels should be stored separately and the mixing should be done just before firing to obtain best results. Home owners who have automatic stokers designed for anthracite should not attempt to use a substitute fuel or even a mixture of anthracite and bituminous. Copies of the new booklet, Information Circular 7260 may be obtained from the Bureau of Mines, Department of the Interior, Washington 25, D. C.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15 Minutes a Day * * * Oil on Troubled Waters, an interesting and somewhat non-technical story of how Shell turbo oil products protects the turbines that drive big ships, illustrated with some interesting turbine photographs; Shell Progress, September-October, 1943, Shell Oil Co. * * * Camp Parks Builds Seabees, an illustrated story of the training camp for these gun-and-hammer-toting men of the U. S. Navy; How Low Temperatures Are Used to Test Oil; both in Weather Magic, October, 1943, The Trane Co. * * * Preventing Rust by Displacing Water, a discussion of the fundamental principles underlying the action of certain products that prevent rust of metal; What Science Has Done for Lubrication; The Houghton Line, November, 1943, E. F. Houghton & Co. * * * Women in Industry, a survey covering employment of women in industry; National Metal Trades Association (prepared, incidentally, by Edward J. Kunze, industrial engineer, N.M.T.A., former associate editor of Power Plant Engineering) * * * The Story of the Turbine, a very well-illustrated, non-technical treatment of the steam turbine, giving something of its history, its fundamental operating principles, and its future; useful for an engineer to hand to some non-technical friend who asks for some information on the subject; a 24-page, paper bound booklet issued by General Electric Company * * * Ashley Coal Towers Come Down, telling how unused coal towers at the Ashley Street plant of Union Electric Co. have gone into the scrap drive; Union Electric Magazine, November, 1943, Union Electric Co. of Missouri * * * Surface Finish, What It Is—in short, exactly what do we mean in an engineering or scientific sense by a rough or a smooth surface, and how do we determine it? Well illustrated with diagrams and photographs; Grits and Grinds, October, 1943, Norton Company * * * A Man-Made Coal Mine, detailed description of the very realistic reproduction of a coal mine installed in the Museum of Science and Industry, founded by Julius Rosenwald in Chicago (and from personal inspection we can assure you that it is extremely realistic) The Fusion Point, October-November, 1943, Southern Coal Co., Inc. * * * Mules of Our Mechanized Army, a collection of fascinating photographs, taken right on the spot, of various types of tractors and equipment in actual service on the battlefronts; Caterpillar Magazine, Issue 87, Caterpillar Tractor Co. * * * Copper and Brass in the Textile Industries, detailing with many good illustrations some of the uses of these materials in the industry and including some fine photographs of uniforms of all the services; Copper & Brass Research Association * * * Cigarette Paper, full details and illustrations of how it is made; Seamless and Welded Steel Pipe, discussion of the principles and equipment used in fabricating it; Postwar Electrification in South America, a study of the present and future potentialities; all in Compressed Air Magazine, December, 1943 * * * Placement of Extinguishers Important, an illustrated article showing how to be sure you have the right type of extinguisher in the right place; High Pressure, November, 1943, Walter Kidde & Co., Inc.

SIMPLIFIED ELECTRON MICROSCOPES, to be shipped on high priority orders to industrial laboratories and colleges so that they may obtain experience in the use of this new scientific tool, are now being produced in small quantities by General Electric Co. These microscopes, which operate on ordinary house current, are capable of producing images 10,000 times the size of the specimen, and are approximately ten times more powerful than the best light microscopes.

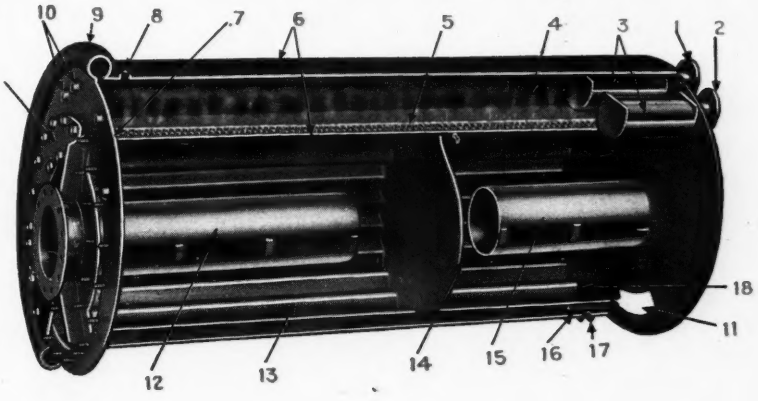
PARTICIPATION BY The American Standards Association in an Allied Nations Standards Body if and when such an organization is formed, has been authorized by the Board of Directors of the ASA. The organization of such a body has been discussed informally for a number of weeks between the British Standards Institution, the Canadian Engineering Standards Association, the American Standards Association and also with key governmental agencies in the three countries. The function of the organization would be to initiate cooperation between the allied belligerent countries in standardization matters as an aid to production and use, not only to coordinate the war effort but to improve operations in the immediate postwar period. This was announced at the recent ASA meeting held in New York to celebrate a quarter century of service to industry and government in the field of standards.

IF YOU ARE what the newspaper reporters like to call an "inveterate" smoker, like this writer (see page 85, Power Plant Engineering, January, 1943) you have probably had many lectures from your physician about the evils of this practice, the severity of the condemnation being in inverse proportion to the physician's own combustion of the weed. For that reason, you will probably be knocked right off your chair by the flat statement, made by Drs. Haag and Larson of Virginia's department of pharmacology, that something in the human body takes the nick out of nicotine before it does the heavy smoker any discernible damage. By a curious coincidence, this conclusion was reported before the Medical Society of Virginia, a state which, by another curious coincidence, boasts about the amount and quality of tobacco it produces. Just how the body goes about rendering nicotine harmless is not definitely known. But it appears that some factor, possibly the liver, alters the nicotine chemically. About 10 per cent of the nicotine taken in is eliminated from the body and the doctors can only conclude that the remainder of 90 per cent is altered chemically in the body. If this were not so, it is hardly possible that you could smoke anywhere near the amount of tobacco you do without developing major toxic phenomena. The most interesting thing about this whole business is that, for once, scientific research tells us something that confirms what we have always wanted to believe instead of telling us we are all full of balloon juice and prop wash.

A NUMBER of readers of our September, 1943, special section on Employee Training Programs in Wartime expressed interest in the brief statement on page 66 of that issue about the job break-down program of Idaho Power Company, submitted by E. A. Woodhead, in charge of plant construction and operation for the company. For those who want more details about this job break-down plan than we could fit into that issue, note that *Electrical World*, in its December 11, 1943 issue, published a long article by Mr. Woodhead, telling exactly how the plan operates in detail and giving some of the results of it on specific jobs. For example, one 56-day task was cleaned up in 19 days by this method, with lost-time generation charge cut two-thirds. In these days of stress, it is not necessary to belabor the importance of plant outages. It has seemed to us that the job break-down plan should lend itself readily to almost any power plant maintenance or repair job, large or small, and to many of the maintenance jobs around industrial plants in distribution and utilization equipment. We are very glad that the *World* has made more details of this plan available to the power engineering field.

MAXIM HEAT RECOVERY SILENCERS *save fuel!*

Extra steam or hot water for industrial processing operations or for heating purposes can be readily obtained by utilizing waste exhaust heat with Maxim Heat Recovery Silencers. The fuel saving is obvious, as the heat source is simply the engine exhaust gases which normally are wasted.



1—Steam Outlet
2—Safety Valve Connection
3—Dry Pipes
4—Steam Space
5—Water Line
6—Shells—Cylindrical to withstand steam pressure and pulsating gas flow
7—Inlet Head
8—Pressure Gauge Connection
9—Expansion Joint—permits dry operation
10—Water Gauge Connections
11—Cleanouts—provide easy access for cleaning heating surface
12—Inlet Bleeder Tube
13—Extended Heating Surface—forming conduits for leading exhaust gases from one attenuating chamber to the other
14—Insulated Intermediate Head
15—Outlet Bleeder Tube
16—Feed Water Deflector Plate
17—Feed Water Connection
18—Exhaust Gas Outlet from side conduits formed by extended heating surfaces

HIGH HEAT RECOVERY... Maxim Heat Recovery Silencers achieve highly efficient heat transfer through high mass gas velocities and the use of extended heating surfaces, a type of construction that is extremely dependable and requires minimum attention.

HIGH DEGREE OF SILENCING... These units embody the Maxim principle of silencing and can be had with or without the spark arresting feature. Based on silencing principles pioneered by Maxim and developed through years of practical field experience, they afford highly effective silencing of exhaust with minimum of back pressure.

COMPACTNESS AND LIGHT WEIGHT... Maxim Heat Recovery Silencers are extremely compact and can in most cases be installed in the space normally used for a regular silencer unit.

AUTOMATIC CONTROL... In the boiler, the steaming rate is controlled by varying the amount of water in contact with the heating surface; low water, less effective heating surface; high level, more effective. The control is accomplished automatically by two steam pressure regulated valves, one in the feed line, one in the return line, working in conjunction. (See bulletin WH-100)

ABILITY TO RUN DRY... Because of the type of construction, with extended heating surfaces, not tubes, it is possible to run these units dry without any danger of damage.

QUICK RETURN ON INVESTMENT... Maxim Heat Recovery Silencers produce usable steam or hot water from a present source of heat. Hence steam or hot water for processing operations or for heating the plant is available with no extra fuel cost. This obvious saving represents a quick and often substantial return on your investment.

AVAILABILITY... At this time the Maxim Silencer Company's production is devoted to war needs. It is our feeling, however, that this Waste Heat story has sufficient post-war importance to make your investigation worthwhile now, whether or not your present priority status allows immediate purchase of the equipment.

This northern Minnesota power plant is heated entirely through use of Maxim Heat Recovery Silencers.

SEND FOR DESCRIPTIVE BULLETINS

Maxim Waste Heat Bulletins WH-100, WH-102 and WH-103 will be sent to you on request. Simply send your request to The Maxim Silencer Company at the address below.

THE MAXIM SILENCER CO.
89 Homestead Ave., Hartford, Conn.

MAXIM

THE UNIT TANDEM

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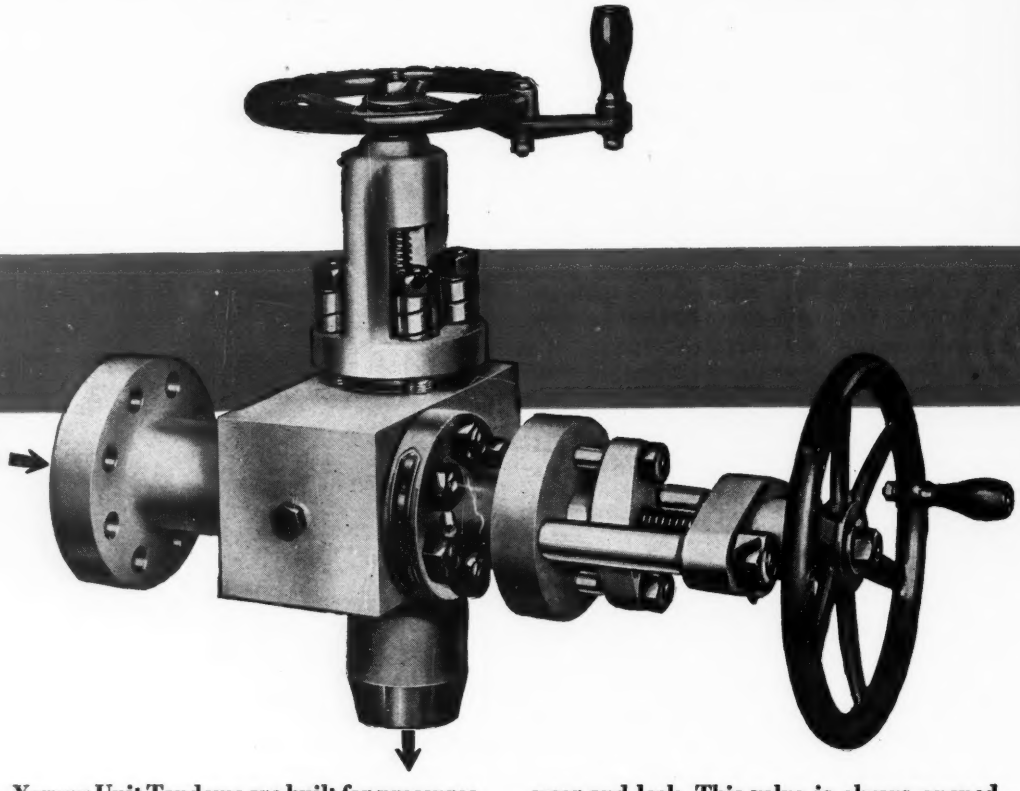
Yarway's Finest Blow-Off Valve for the Highest Pressure Service

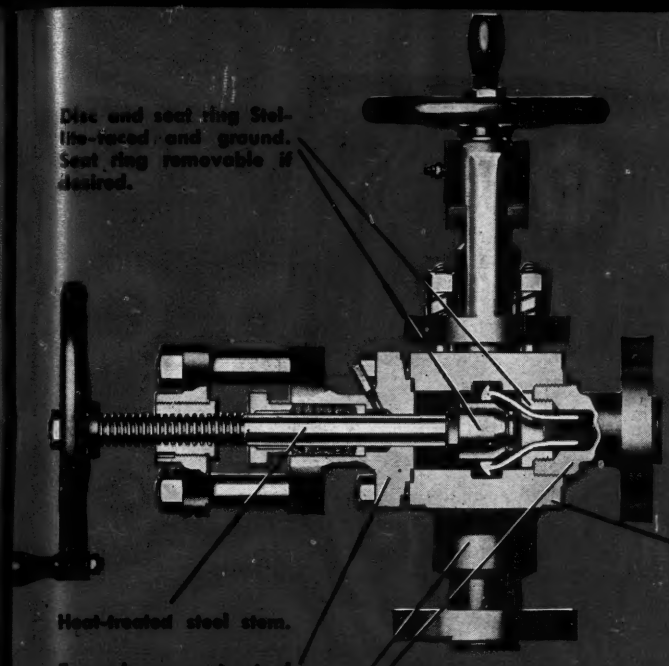


Yarway Unit Tandems are built for pressures up to 2500 lb. Combining a Hard-Seat and a Seatless valve in a single one-piece forged steel body, this Tandem provides the advantages of both designs — for blowing and for sealing — in a compact, rugged unit.

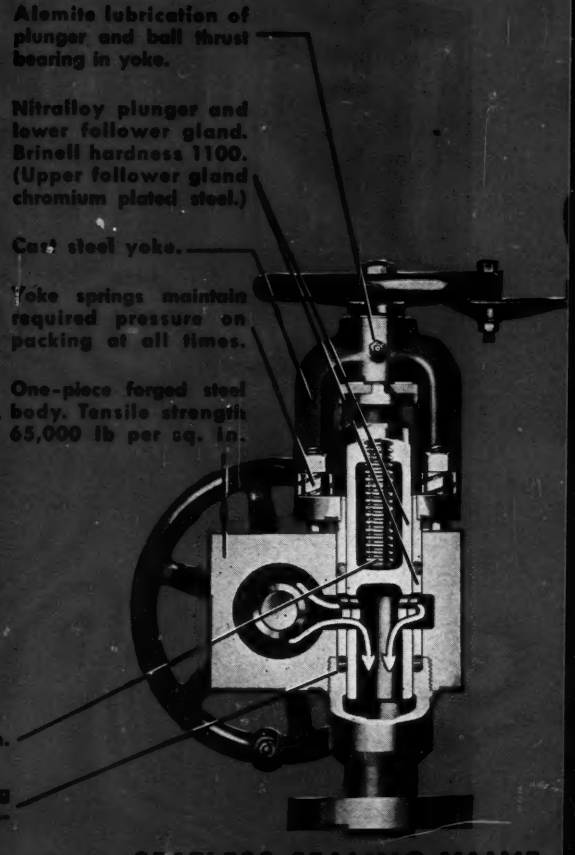
Outside sealing valve is the famous Yarway Seatless design which has no seat to score, wear and leak. This valve is always opened first and closed last, maintaining a tight seal at all times.

Inside (next to boiler) blowing valve is the Yarway Hard-Seat Valve which utilizes special alloys and unique construction features to reduce materially normal wear in this type of valve.

YARWAY


Disc and seat ring Stellite-faced and ground. Seat ring removable if desired.
Heat-treated steel stem.
Forged or cast steel bonnet.
Inlet and Outlet Nozzles threaded and welded into body. Flanged or welding ends provided.

HARD SEAT BLOWING VALVE


Alemite lubrication of plunger and ball thrust bearing in yoke.
Nitralloy plunger and lower follower gland. Brinell hardness 1100. (Upper follower gland chromium plated steel.)
Cast steel yoke.
Yoke springs maintain required pressure on packing at all times.
One-piece forged steel body. Tensile strength 65,000 lb per sq. in.
Heat-treated steel stem.
Laminated packing ring with stainless steel reinforcing inserts.

SEATLESS SEALING VALVE

A Quarter Century of Product Development

Years of service in the high pressure plants of leading Utilities and Industrials have proved the soundness of design and metallurgy of the Yarway Unit Tandem.

Such records as—"3000 blows at more than 1300 lb pressure, without replacement of a single part or repairs of any nature"—have made this Tandem the outstanding preference for high pressure service, today.

Good boiler engineering demands equally sound engineering in the accessories that become part of it. It is not only protection for your investment, but cheap insurance against trouble and expense. The reason why most people specify Yarway Blow-Off Valves.

What are your draining or blow-down requirements? Write for Catalog. Section B-431 for pressures up to 2500 lb; Section B-422 for lower pressures.

YARNALL-WARING COMPANY
114 Mermaid Ave., Phila. 18, Pa.

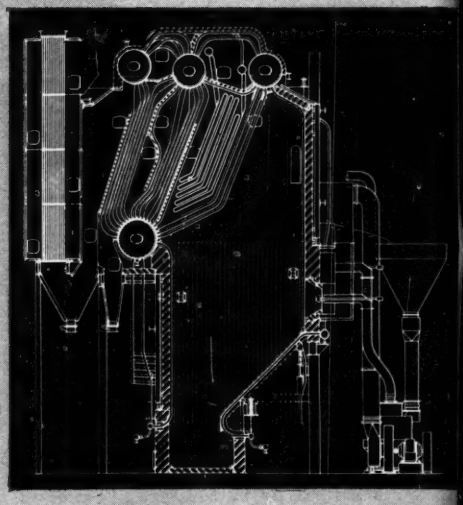
BLOW-OFF VALVES

B&W EQUIPMENT HELPS MAINTAIN *all out steam generation in spite of manpower shortage*

B&W not only fabricates boilers for a wide variety of installations but through its unequalled experience and progressive engineering has developed design details that are paying high dividends today in the maintenance of the gruelling operating schedules imposed by wartime manufacturing conditions. Scores of B&W boilers are operating today that were operating before the last war. The record speaks for itself. Only good design, fine workmanship, and use of the best materials could make such a record. Today's boilers, even better designed and built, are everywhere providing the service that conserves fuel, materials, and manpower—important factors in this critical period in steam-power generation.

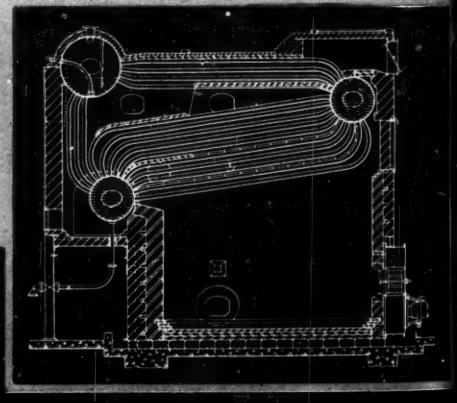
STIRLING BOILER

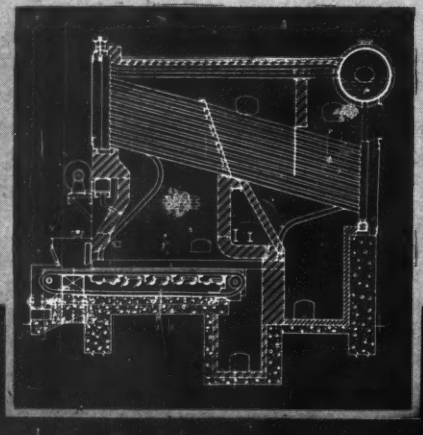
The Stirling Boiler fully meets the requirements of modern operating conditions. It readily responds to sudden and heavy demands for steam, and delivers dry steam at relatively high ratings when operated with water having a high concentration of solids. May be fired with any fuel.



TYPE H STIRLING BOILER

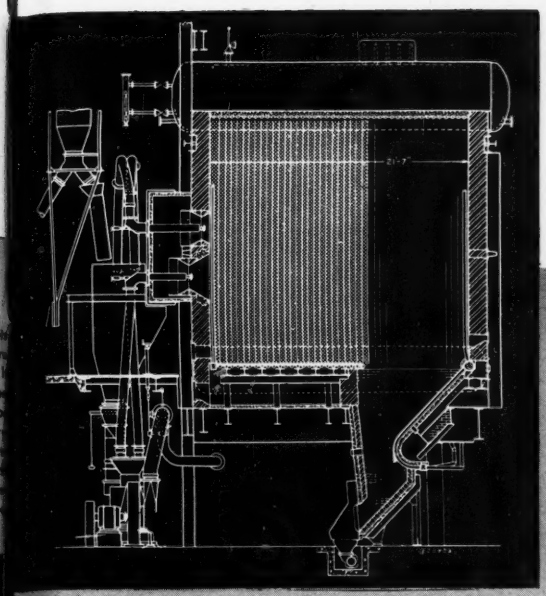
A low-head moderate-pressure unit that is widely used in small industrial plants, institutions, hotels, office buildings and to meet other similar requirements. Available in capacities ranging from 1500 to 30,000 lb. steam per hr. and for firing with any fuel. The furnace, usually of refractory, provides the necessary degree of dependability.





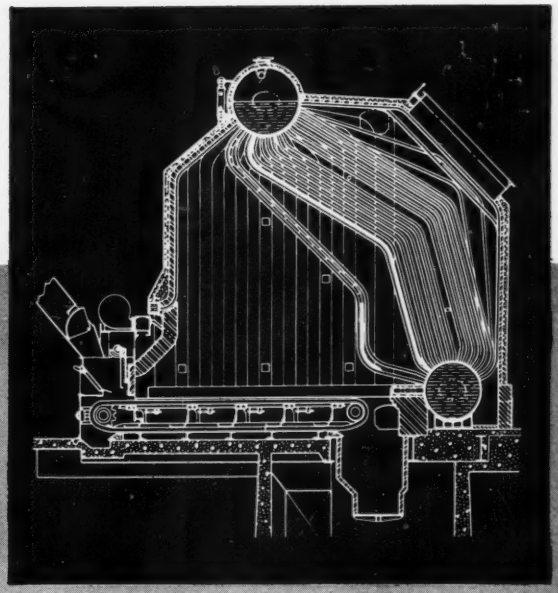
B&W DESIGN 32 CROSS-DRUM BOILER

This unit is widely used in small and medium-size power plants where refractory furnaces are suitable. It provides the advantages of the straight-tube, sectional-header construction used in B&W Cross-Drum Boilers designed for larger capacities.



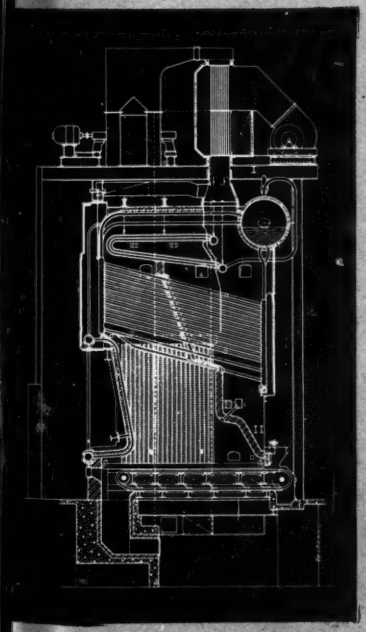
INTEGRAL-FURNACE BOILER

The Integral-Furnace Boiler is a completely co-ordinated unit built in capacities up to 250,000 lb. steam per hr. and for the pressures and temperatures required by the most up-to-date and efficient prime movers. It is designed to burn pulverized solid fuels, oil, or gas, singly or in combination, thus utilizing at high combustion efficiency the least expensive fuel obtainable in any locality.



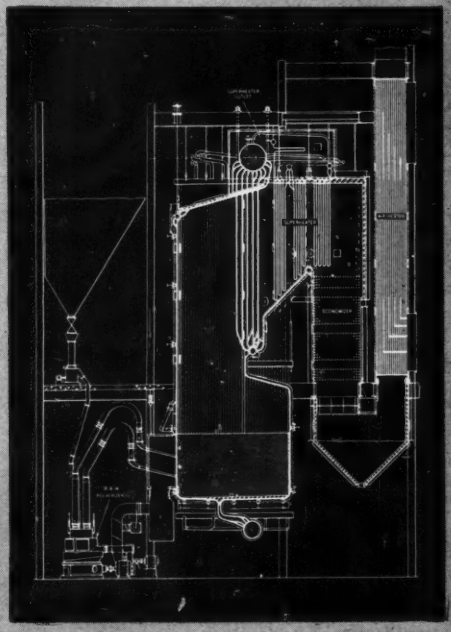
B&W INTEGRAL-FURNACE BOILER (CLASSES 9, 12, & 15)

This Integral-Furnace Boiler is available for firing with stokers or with oil, and in sizes ranging from 1353 to 6506 sq. ft. of heating surface. Having a water-cooled furnace of special design, this boiler provides the dependability of central-station boilers, with efficient and smokeless combustion.



B&W CROSS-DRUM BOILER

This straight-tube sectional-header boiler is noted for its dependability, long life, and ability to deliver dry steam at high ratings. Can be readily inspected and cleaned.



CENTRAL-STATION BOILERS

High-duty boilers for central-station service are available in several basic designs to meet the requirements of individual stations. The Radiant boiler unit illustrated is typical of some of the units now operating at high rates in utility plants.

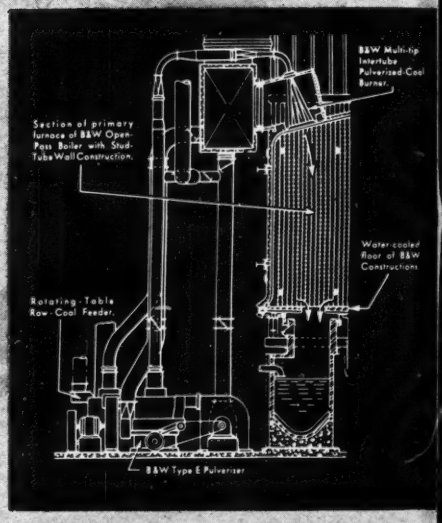
G-261F

B&W Component EQUIPMENT

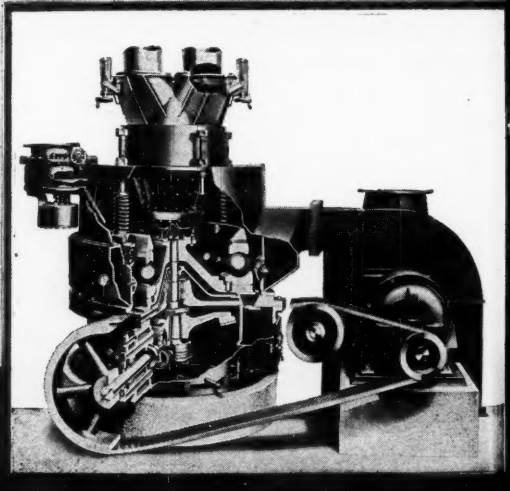
makes maximum use of available men and materials

B&W DIRECT-FIRING PULVERIZED-COAL SYSTEM

B&W direct-firing pulverized-coal system has advantages in ease of operation, reliability and upkeep that make it economical for small as well as large boilers. It is readily applied to oil-fired boilers for conversion to coal firing.


B&W Multi-tip Intertube Pulverized-Coal Burner.
Section of primary furnace of B&W Open-Pass Boiler with Stud-Tube Wall Construction.
Water-cooled floor of B&W Construction.
Rotating-Table Raw-Coal Feeder.
B&W Type E Pulverizer

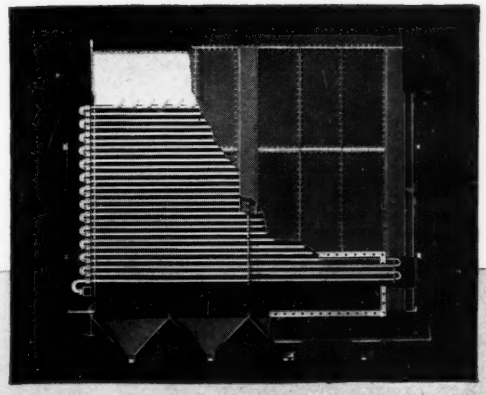
It is definitely certain that a chain is no stronger than its weakest link. Similarly, a steam-power boiler unit, composed as it is of elements additional to the boiler proper, must be equally as reliable from fuel entrance to flue-gas outlet. Component equipment of B&W boiler units, shown on these pages, is engineered and fabricated for complete co-ordination of operational functions to meet specific requirements exactly and to assure to power plant operators the attainment of design efficiency. They also provide the dependability and availability for service that are necessary to meet today's handicap of shortages in materials for replacement and in manpower for operation and maintenance.



B&W PULVERIZERS

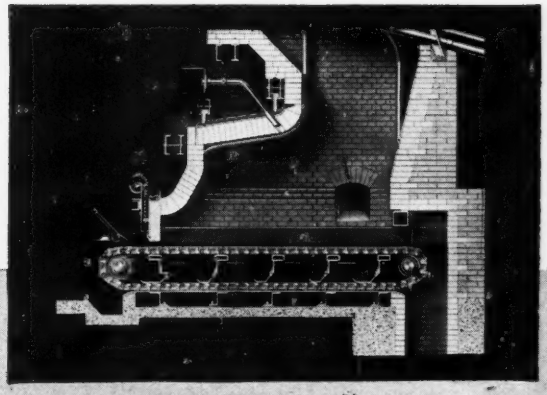
The simplicity and sturdiness of B&W ball-bearing type pulverizers assure high availability with low maintenance in direct-firing pulverized-coal systems. They provide consistently high fineness and respond quickly to changes in load with automatic control of raw-coal feed.

★ BUY MORE WAR BONDS! ★



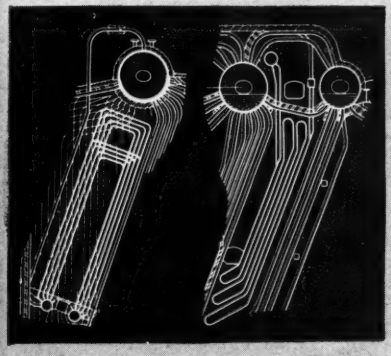
ECONOMIZERS

B&W Economizers effect appreciable savings in fuel and can be built to meet the size and pressure requirements of any installation. The Return-Bend Economizer shown can be easily cleaned, and pressure parts may be inspected externally while in service.



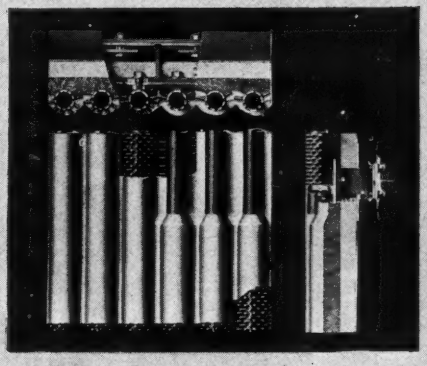
CHAIN-GRATE STOKERS

Babcock & Wilcox Chain-Grate Stokers are widely used with free-burning bituminous coal, anthracite, lignite, and coke breeze. They can be furnished for natural, induced, or forced draft, depending upon operating conditions.



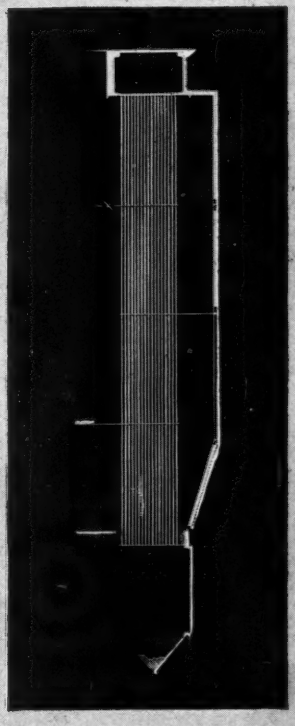
SUPERHEATERS

B&W Superheaters are properly designed and fabricated, with respect to steam and gas flow, to function efficiently with boilers designed and built by B&W. Available in both draining and non-draining types as shown.



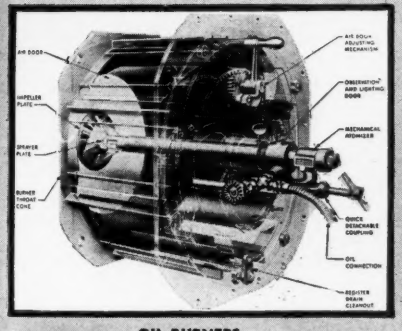
WATER-COOLED FURNACE CONSTRUCTIONS

B&W Water-Cooled Furnace Constructions are extensively applied for partial or complete water cooling of furnaces of all sizes, shapes, and forms, and with all fuels and combustion methods. Studded-tube type of construction is shown.



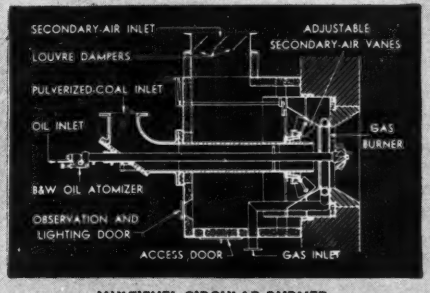
AIR HEATERS

B&W Tubular Air Heaters are inherently tight and efficient, and are easy to keep clean. Available in multi-pass gas flow type, as shown, or longitudinal gas-flow type, and in sizes to meet the requirements of any boiler installation.



OIL BURNERS

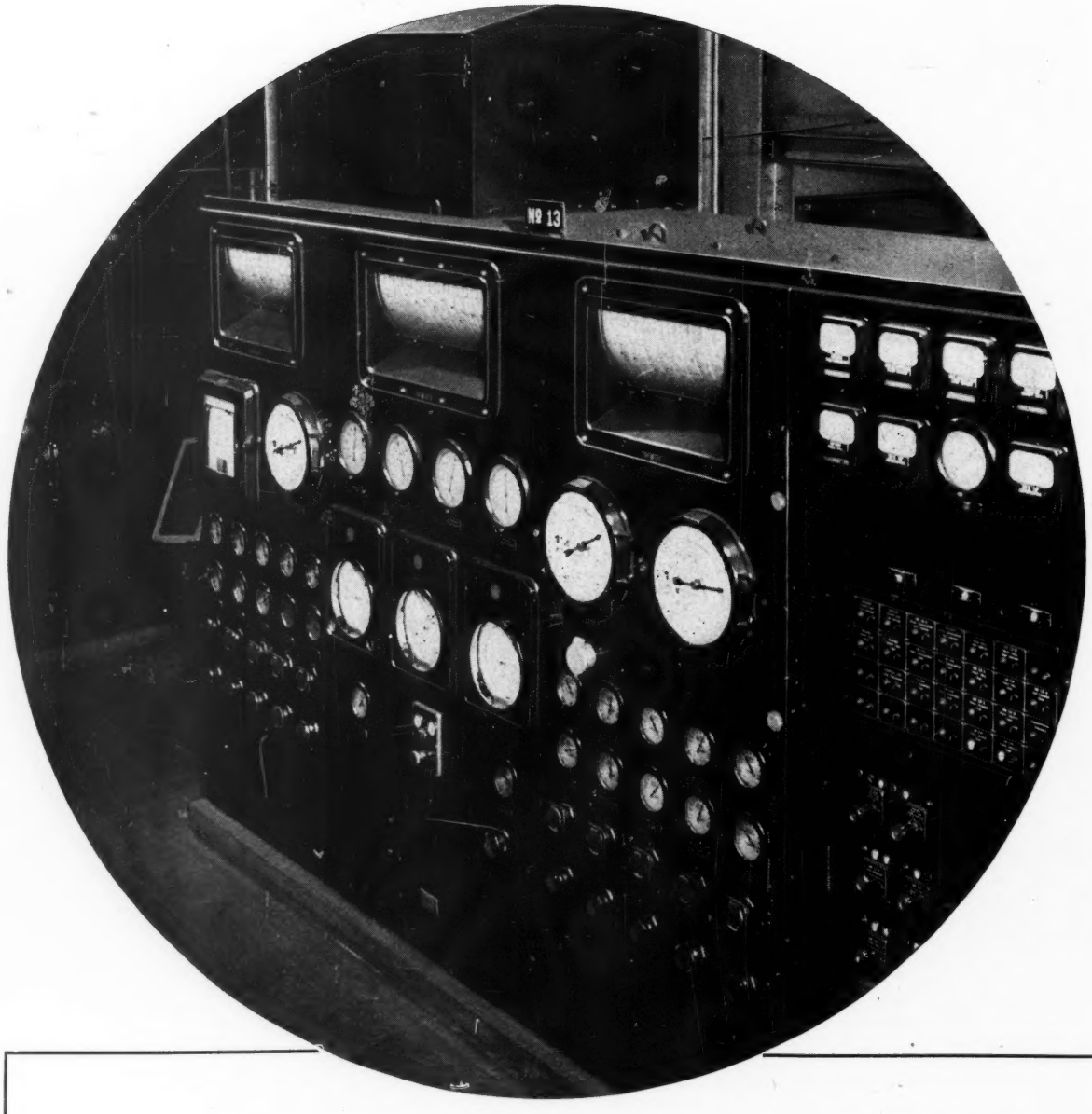
B&W Oil Burners effect rapid and complete combustion at all rates of fuel feed, using mechanical, steam, or steam-mechanical atomizers, depending on the oil and operating conditions. Available in a range of heat liberating capacities that meet all requirements.



MULTIFUEL CIRCULAR BURNER

Pulverized solid fuels, oil, and gas are burned singly or in any combination with this burner. It provides a single means of efficiently burning a wide range of fuels, permitting advantage to be taken of variations in the availability and market prices of these fuels.

For America's s



HAGAN CONTROL ASSURES . . .

● **MAXIMUM QUANTITY** of steam from any given plant, by introducing fuel and air in correct proportion for utmost efficiency.

● **MAXIMUM UTILIZATION** value, uniform steam pressure and temperature, in accordance with demand.

● **MAXIMUM OUTPUT** from boilers of differing capacities, automatically.

● **MAXIMUM STEAM** for production, by reducing loss of steam in frequent soot-blowing.

● **MAXIMUM PROTECTION** of auxiliary equipment, fans, stokers, etc., by maintenance of uniform operating conditions.

Sake *read this* . .

THEN ACT!

FACING THE FUEL CRISIS, *you* can't make up lost coal production. Nobody can . . . now.

But you *can* conserve existing stockpiles and stretch new coal deliveries by increasing your fuel efficiency with automatic combustion control.

Over a period of many years, several reputable American companies have perfected equipment for automatically insuring maximum combustion efficiency in steam boilers.

If your boiler plant is *not* equipped with this proven, fuel-saving equipment, ***it should be.***

If your plant *is* equipped with combustion control—which may not be strictly up-to-date or in perfect adjustment—call in a combustion specialist . . . any good one. He can inject new vigor and fresh efficiency to sub-par apparatus—quickly, simply, economically.

America's coal pile is vital to the war effort—***don't waste it!*** Get in touch with us—or one of our competitors—***immediately.*** The ***all-important*** thing is to ***save fuel.***

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30, PA.

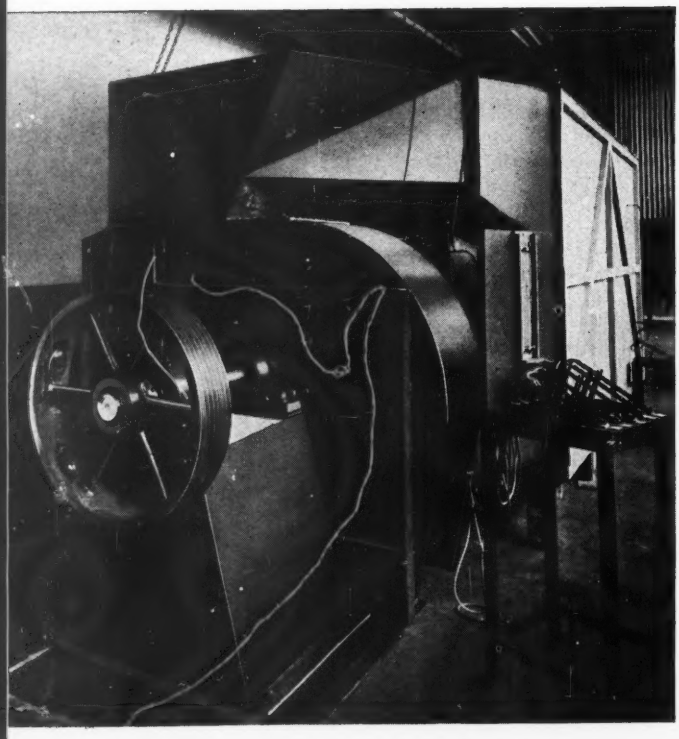
HAGAN
HALL
BUROMIN
CALGON

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

DETROIT PUBLIC LIBRARY

Progress and Power in the



A test conducted in the American Blower research laboratory to determine the air flow and resistance of a dehydrogenation catalyst case.

Tremendous progress has been made in the rubber industry. New developments . . . new processes . . . new synthetics . . . entirely new plants.

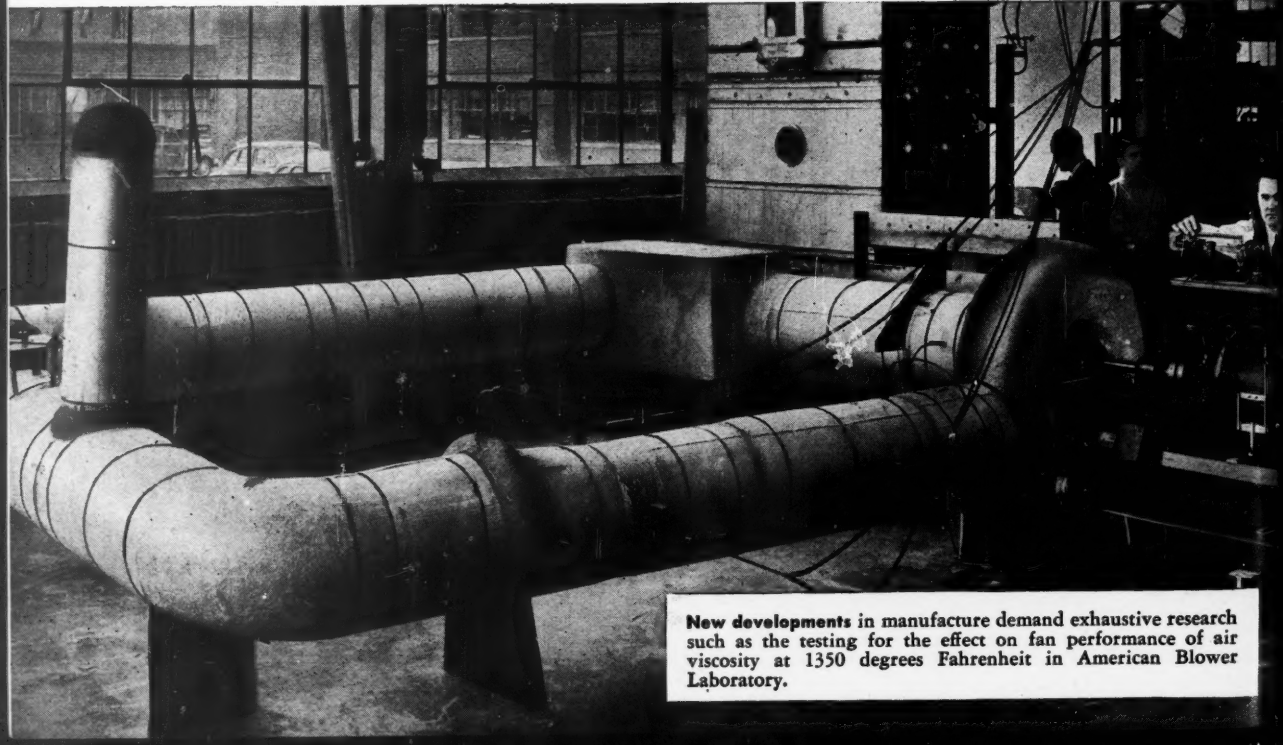
Behind this seemingly impossible task lies a story of co-operation — close co-operation on the part of machinery manufacturers and co-operation on the part of America's great Public Utilities in furnishing the added power to produce the goods.

American Blower co-operated by conducting exhaustive research studies and developing special air handling and conditioning equipment to withstand the grueling conditions of a greatly expanded rubber industry. Our knowledge gained through the years, building standard as well as specialized air handling equipment for industry, is available to you.

AMERICAN BLOWER

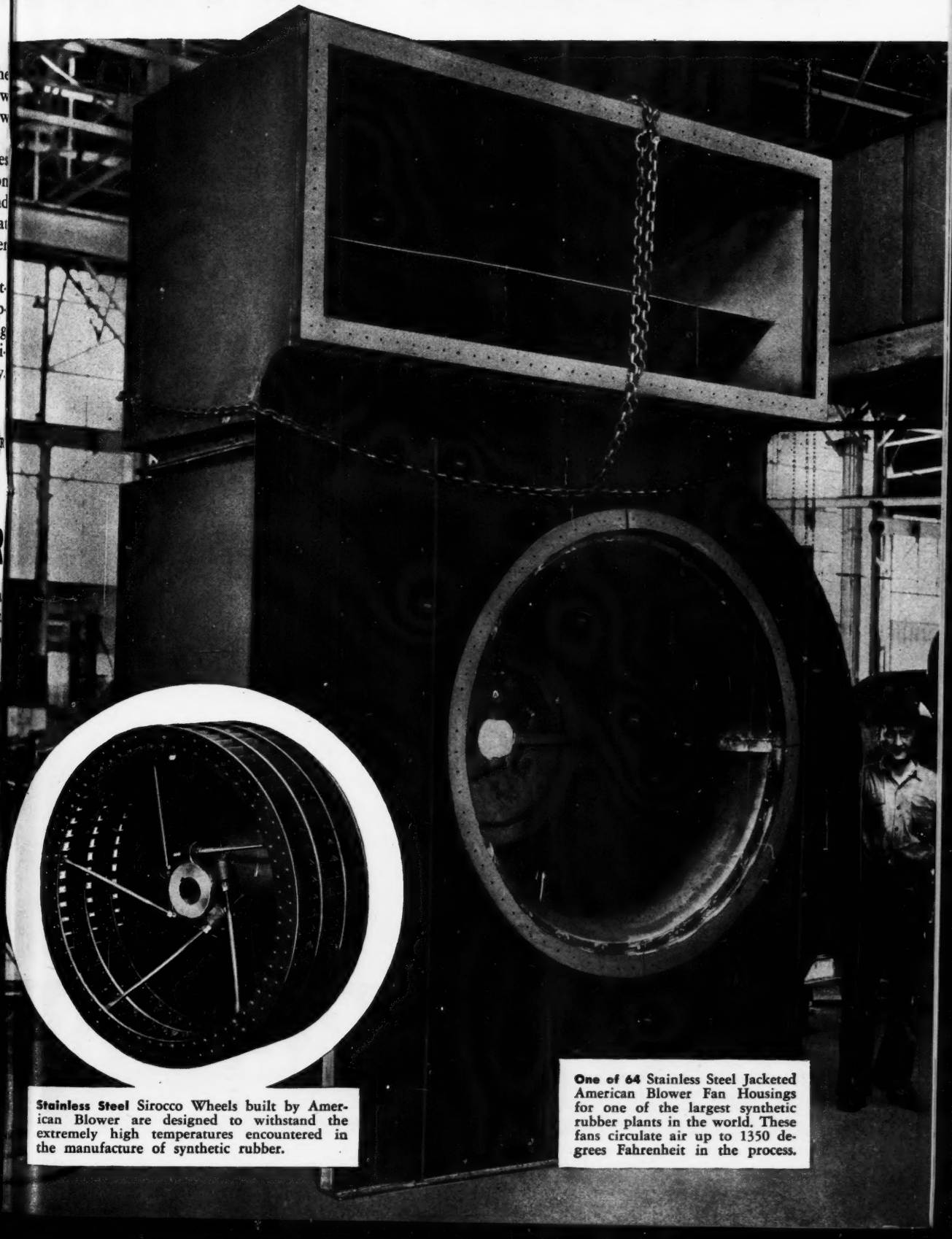
ARMY E NAVY
For Production "Well Done"

AMERICAN BLOWER CORPORATION, DETROIT, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.
Division of AMERICAN Radiator & Standard Sanitary Corporation



New developments in manufacture demand exhaustive research such as the testing for the effect on fan performance of air viscosity at 1350 degrees Fahrenheit in American Blower Laboratory.

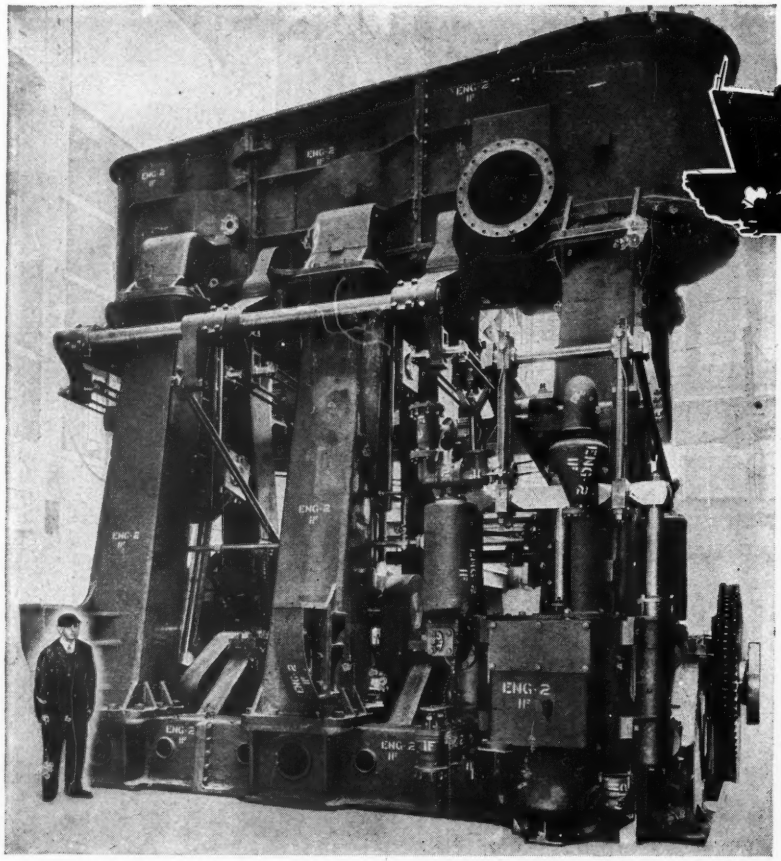
RUBBER INDUSTRY



Stainless Steel Sirocco Wheels built by American Blower are designed to withstand the extremely high temperatures encountered in the manufacture of synthetic rubber.

One of 64 Stainless Steel Jacketed American Blower Fan Housings for one of the largest synthetic rubber plants in the world. These fans circulate air up to 1350 degrees Fahrenheit in the process.

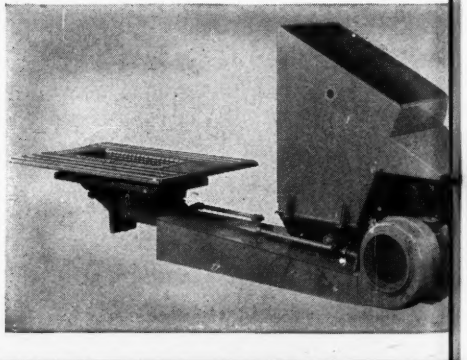
IRON FIREMAN WAR
Marine Engines



Notice size of Iron Fireman marine engine compared to man at left.

TWO months after Pearl Harbor, Iron Fireman was given an order for 2500 horsepower triple expansion marine engines for Liberty ships. More orders have followed and today Iron Fireman is one of the largest producers of these engines, with an output of 30 engines per month.

Iron Fireman engines weigh 270,000 pounds, have a stroke of 48 inches, with cylinders ranging from 24½ inches in diameter in the high-pressure-cylinder to 37 inches in the medium-pressure-cylinder and to 70 inches in the low-pressure-cylinder. Each engine contains 15,542 separate parts, These engines power the famous Liberty ships produced by Henry Kaiser and other shipbuilders.



World's Largest Producer of Coal Stokers

Iron Fireman is the pioneer and world's largest builder of automatic coal stokers. Iron Fireman stokers are the standard of value in coal firing equipment. A national organization of factory-trained engineers and dealers is doing a tremendous job in installing and servicing stokers in power and heating plants throughout the country. Iron Fireman is operating three shifts a day building commercial heating and industrial power stokers to convert oil and hand-fired plants to automatic coal firing.

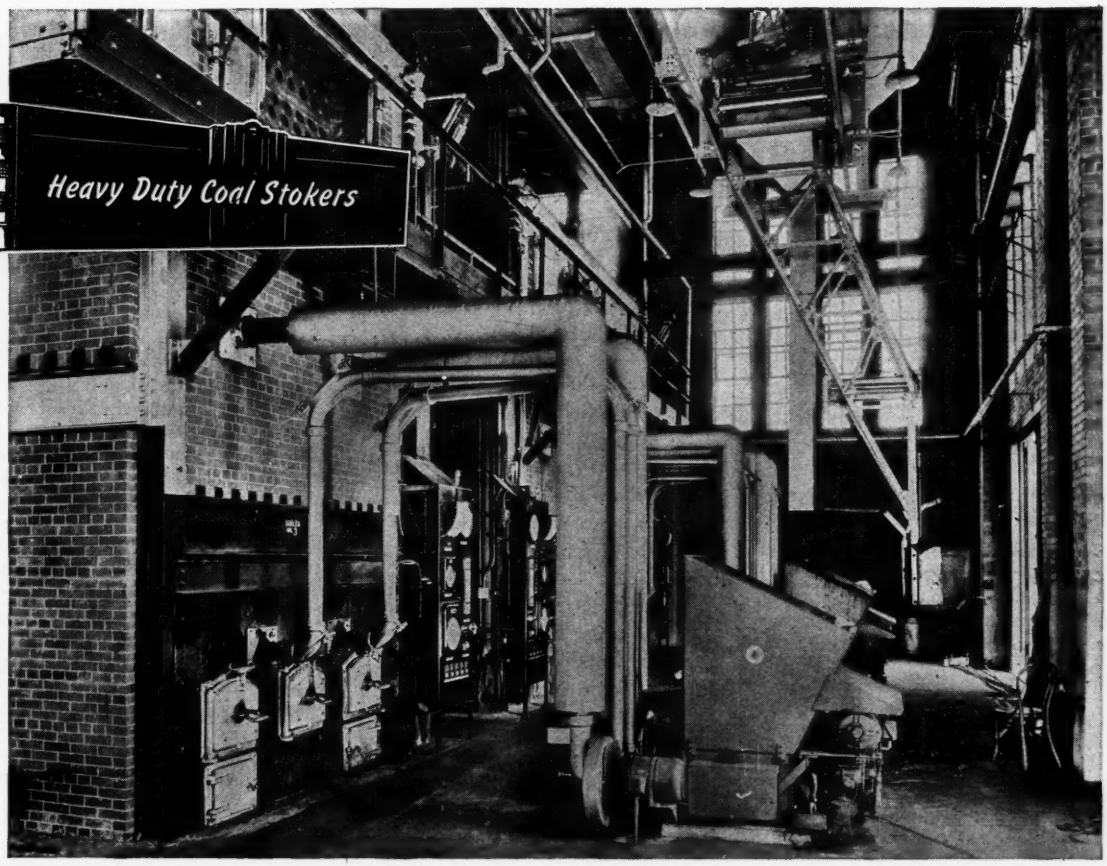
Iron Fireman stokers are engineered to burn efficiently all types and grades of coals. Our nationwide organization of qualified factory representatives and dealers is at your service. Write or wire the Iron Fireman Manufacturing Company, 3523 West 106th Street, Cleveland 11, Ohio. Plants in Portland, Oregon; Cleveland, Ohio; Toronto, Canada.

IRON FIREMAN

THE IRON FIREMAN

Airplane and Ordnance Parts

WORK Includes as well as stokers



The dual nozzles of this Iron Fireman Pneumatic Spreader stoker convey coal to two boilers. Pneumatic Spreader stokers fire boilers developing up to 1,000 horsepower and larger.

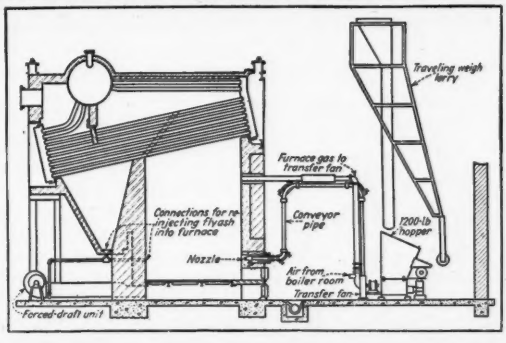
Heavy Duty Poweram Underfeed Stoker

The Iron Fireman Poweram stoker, designed for heavy, continuous loads, combines *worm feed* with *ram distribution* of coal. The worm conveys the coal to the retort in a loose, aerated condition; reciprocating blocks distribute it evenly and prevent packing.

Illustration shows hopper model. Bunker-feed models also available, which feed direct from main bunker to fire, and eliminate coal handling.

Iron Fireman Pneumatic Spreader Stoker

The Iron Fireman Pneumatic Spreader stoker conveys steam size coal from the hopper or main coal bunker to a transfer housing, where the coal is picked up by a stream of air and conveyed to the furnace or grates. The fines burn in suspension, utilizing the conveying air for combustion. The larger pieces form a shallow fuel bed on the grate. By means of an adjustable nozzle the coal is dropped by gravity and distributed uniformly over the entire grate area.



IRON FIREMAN
THE IRON FIREMAN
Automatic Coal Stokers
rts Marine Engines

Scovill Tube News

Vol. 2 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 1

Longer Tube Life . . A Review Of Information Helpful In Obtaining It

Factors Affecting Tube Life

The service life of condenser and heat exchanger tubes is governed by the following major influences:

1. the composition of the alloy
2. the workmanship and quality of the tubes
3. the conditions of service of the tubes

The most satisfactory tube service and tube performance in a heat exchanger unit is obtained only after a careful consideration of these factors. Some discussion is therefore devoted to each of them.

1. The Composition of the Alloy

The nonferrous alloys for heat exchanger service may be grouped into three broad classifications, as follows:

(a) Copper, Phosphorized Copper and Arsenical Copper

(b) Brasses or Copper Zinc alloys, usually containing small percentages of other metals such as Tin, Aluminum, Nickel, Iron, Lead, etc.

(c) Copper Nickel alloys, containing Copper, Nickel and, in some cases, minor amounts of other elements such as Tin, Iron, Manganese, Zinc, etc.

Most of the tube alloys carry trade names which usually identify them, as for example, muntz metal, naval brass, admiralty metal, red brass, aluminum brass, etc. The choice of any particular alloy for a particular service is based on the known behavior of such alloys under any definite set of conditions, on previous service experience of tubes in the unit in question or similarly operated units, and on the type or form of corrosion which predominates. It may be pointed out, by way of illustration, that copper and alloys of high copper content (85% or over) are not generally recommended for service where corrosion by hydrogen sulphide or similar sulphur compounds is known to be severe; likewise, muntz metal and other alloys of brass high in zinc content (which contain no inhibitive agent) are not serviceable under conditions where serious dezincification may be experienced. On the other hand, tubes of aluminum brass or copper-nickel withstand mechanical abrasion or erosion-corrosion better than other alloys.

Article No. 6 discusses how the right alloy can be selected for the actual operating conditions.

Scovill War-Information Service to Save Scarce Tube Metals

During 1943, *Scovill Tube News* has presented a series of articles on condenser and heat exchanger tubes . . . with the objective of pointing out to engineers certain steps which will be helpful in obtaining longer tube life. This issue reviews the previous articles. Copies of any or all of the articles are available upon writing to Scovill Manufacturing Company, 17 Mill St., Waterbury 91, Conn.

2. Workmanship and Quality of Tubes

The physical or mechanical condition of condenser and heat exchanger tubes is relatively less important as a contributing factor of corrosion than the service conditions to which they are exposed. Nevertheless, deep scratches, seams, folds, unsoundness or other serious metal imperfections in tubes may initiate corrosion of a severe electro chemical type and should be avoided. A high standard of quality in the manufacture of tubes, therefore, is required to insure freedom from this source of trouble. Each step in the production of tubes from the selection of the raw material, through the casting, to the extrusion, drawing and annealing operations requires careful supervision. Mechanical and chemical tests are necessary both on the finished tubes and on material in process. Close cooperation is maintained between Scovill manufacturing departments and the laboratory not only for necessary control work but also for developing new processes, new corrosion-resistant alloys or for any other work leading to technical advancement in the manufacture and use of condenser and heat exchanger tubing.

3. Conditions of Service

Heat exchanger tubes may be required to withstand or resist corrosion by various media under widely varying service conditions. The rate, form and intensity of corrosion of tube materials, and hence their period of service, depends upon the predominating or controlling factor or a certain combination of factors which may be found active for each individual installation. A study and appreciation of these factors as they apply to any particular corrosion problem is necessary not only in the selection of the most satisfactory and economical tube material, but in the proper control of such factors as may be required to extend tube life. The following list covers the most important of the factors which influence corrosion:

a. Temperature (tube-wall)

b. Velocity of media in contact with tubes

c. Hydrogen ion concentration

d. Oxygen concentration

e. Composition of corroding media

f. Stresses acting upon tubes

g. Contact with dissimilar metals

The influence of each of the above factors is considered in Articles No. 2 and 3.

Better understanding of the common causes of corrosion can be obtained from Articles No. 4 and 5, which discuss:

Film formation

Accelerated uniform corrosion

Impingement attack, end corrosion, etc.

Concentration cell action

Deposit attack

Plug- and Layer-Type Dezincification

Galvanic action

One of 3 Scovill Services

This series of advertisements in the form of articles is an adjunct to a complete plan of "Service in Manuals" provided by Scovill engineers — one of the three "Scovill Services". Further information will be found in Scovill's "Condenser Tube" booklet, containing diagrams, formulae, descriptions of alloys.

The second of Scovill's services is "Service in Men", which places at your disposal the knowledge of men with years of specialized experience. The third is "Service in Metals", which offers you complete laboratory and production facilities, available as national needs permit.

Limitation order L-154 issued by the OPM, limits the use of nonferrous condenser tubes in land power stations to Muntz metal for fresh water plants, and Admiralty metal for salt water plants. No nonferrous metals containing more copper and more tin than these two are permitted by the order.

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men

The TERRY

TERRY
SOLID WHEEL TURBINE
ADVANTAGES . . .

— The blades and the wheel (see above) are in one piece so that there are no parts to become loose or work out.

— The blades have large clearances.

— The blades are double rim protected.

— End play will not damage the blading.

— It is impossible for the blades to foul.

— The power producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets and, therefore, close blade clearance is not necessary.

— As the only function of the blades is to form a series of pockets, wear of the blade edges is of little consequence and does not materially affect the horsepower or efficiency. The important part of the bucket is the back, or bottom, which is a solid forging.

— The Terry wheel will withstand abuse that would wreck any built up wheel.

THE TERRY STEAM TURBINE CO.

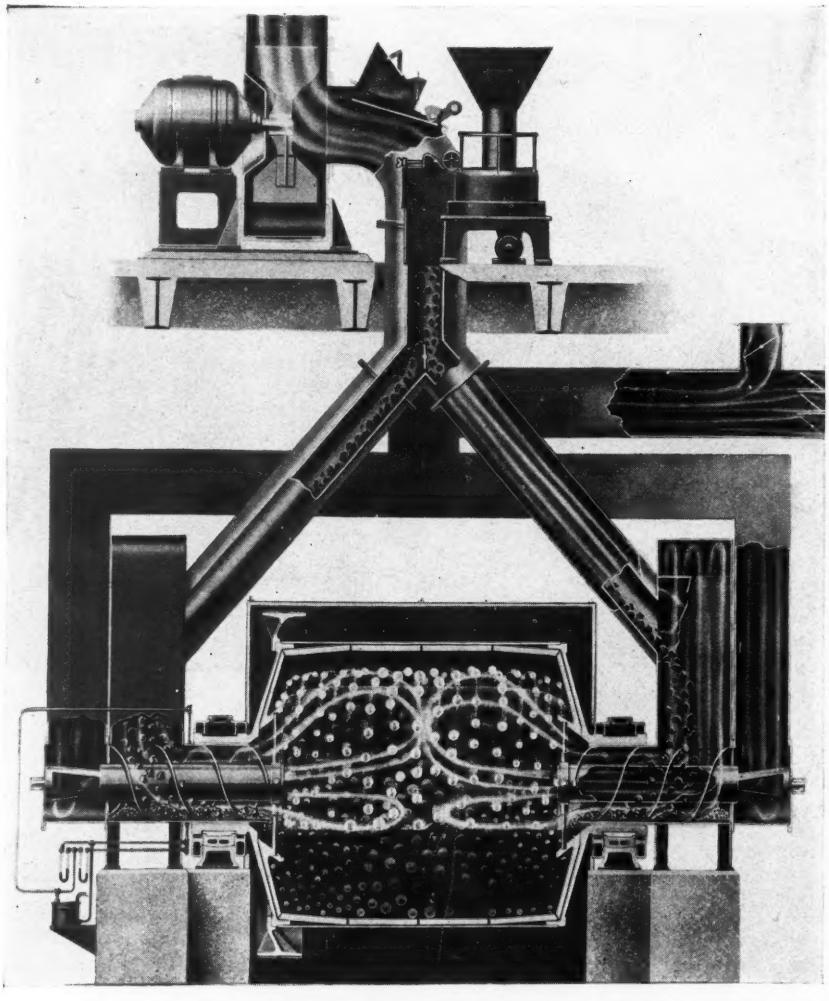
Wheel Turbine

At right—
Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized

T-1147

TERRY SQUARE - HARTFORD, CONN.

Continuous FINE GRINDING of



Fine grinding and Full Capacity are obtained without dependence on close clearances between moving parts.

New Ball charge (the grinding medium) is added during operation as necessary, thus eliminating shut-downs to replace the pulverizing parts.

FW FOSTER

G of PULVERIZED FUEL ASSURES LOWER COST STEAM

The outstanding performance characteristic of Foster Wheeler (Hardinge type) Ball Pulverizers is maintenance of high fineness in the pulverized fuel — over long periods of service without loss in capacity.

This exceptional ability to operate without reduction in fineness or forced outage, effects material savings including:

1. Boiler efficiency maintained for duration of run with resultant low cost for fuel.
2. Boiler outages for cleaning heating surfaces reduced; pulverizer repairs minimized.
3. Labor charges against cleaning boiler and water wall surfaces sharply decreased.

FOSTER WHEELER CORPORATION, 165 Broadway, New York 6, N. Y.

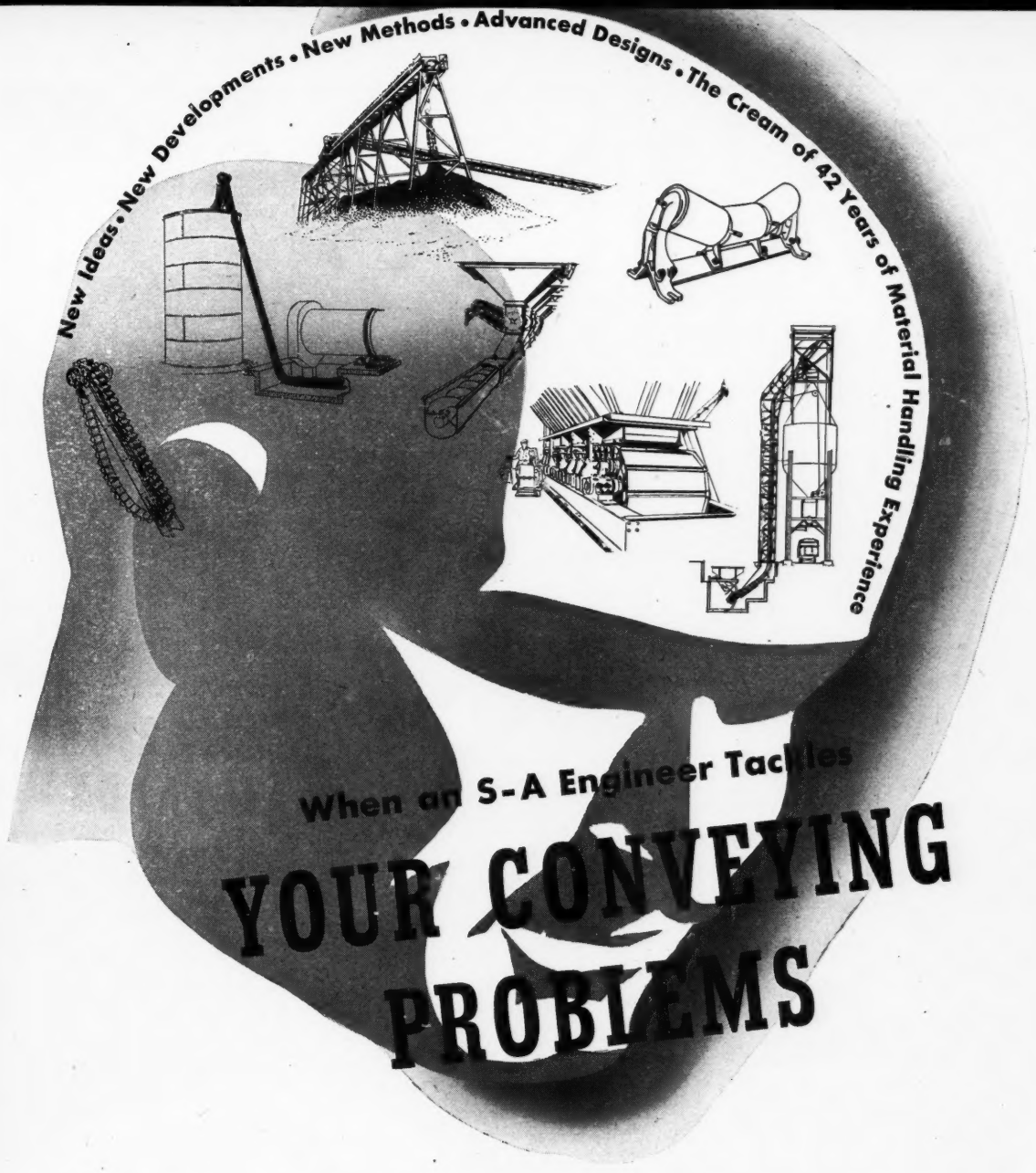
WHEELER FW

These Are Our Boys!

They've got a tough job ahead of them as they step out on this enemy beach. But we know they'll give 'em the works. And we'll give everything we've got back home, too—we'll work overtime without kicking, we'll go easy on gas and tires . . . and we'll buy War Bonds with every extra dollar. *They* are risking their lives . . . and we *must* do *our* part.
THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

GARLOCK

Official U. S. Signal Corps Photo


New Ideas • New Developments • New Methods • Advanced Designs • The Cream of 42 Years of Material Handling Experience
When an S-A Engineer Tackles
YOUR CONVEYING PROBLEMS

• An S-A Engineer has literally a brain-full of material handling ideas and methods, each one backed up by a wide variety of material handling units for putting a planned layout into operation.

It is the S-A Engineer's job to study and analyze *your* handling problems... and to prescribe the *proper method and equipment* necessary to do the job efficiently and economically.

Stephens-Adamson Engineers represent an organization which has, for 42 years, devoted its time and energies exclusively to the development and production of better material handling methods and equipment.

Whether your plans call for immediate action, or for improved material handling systems to be installed for post-war operation, S-A Engineers are ready to serve you.

STEPHENS-ADAMSON MFG. CO.
515 Ridgeway Avenue, Aurora, Illinois
Los Angeles, Calif. Belleville, Ont.

STEPHEN S-A ADAMSON
MFG. CO.

Designers and Manufacturers of All Types of
BULK MATERIAL HANDLING EQUIPMENT

"WINGS" fo

OFFICIAL U. S. NAVY PHOTOGRAPHS

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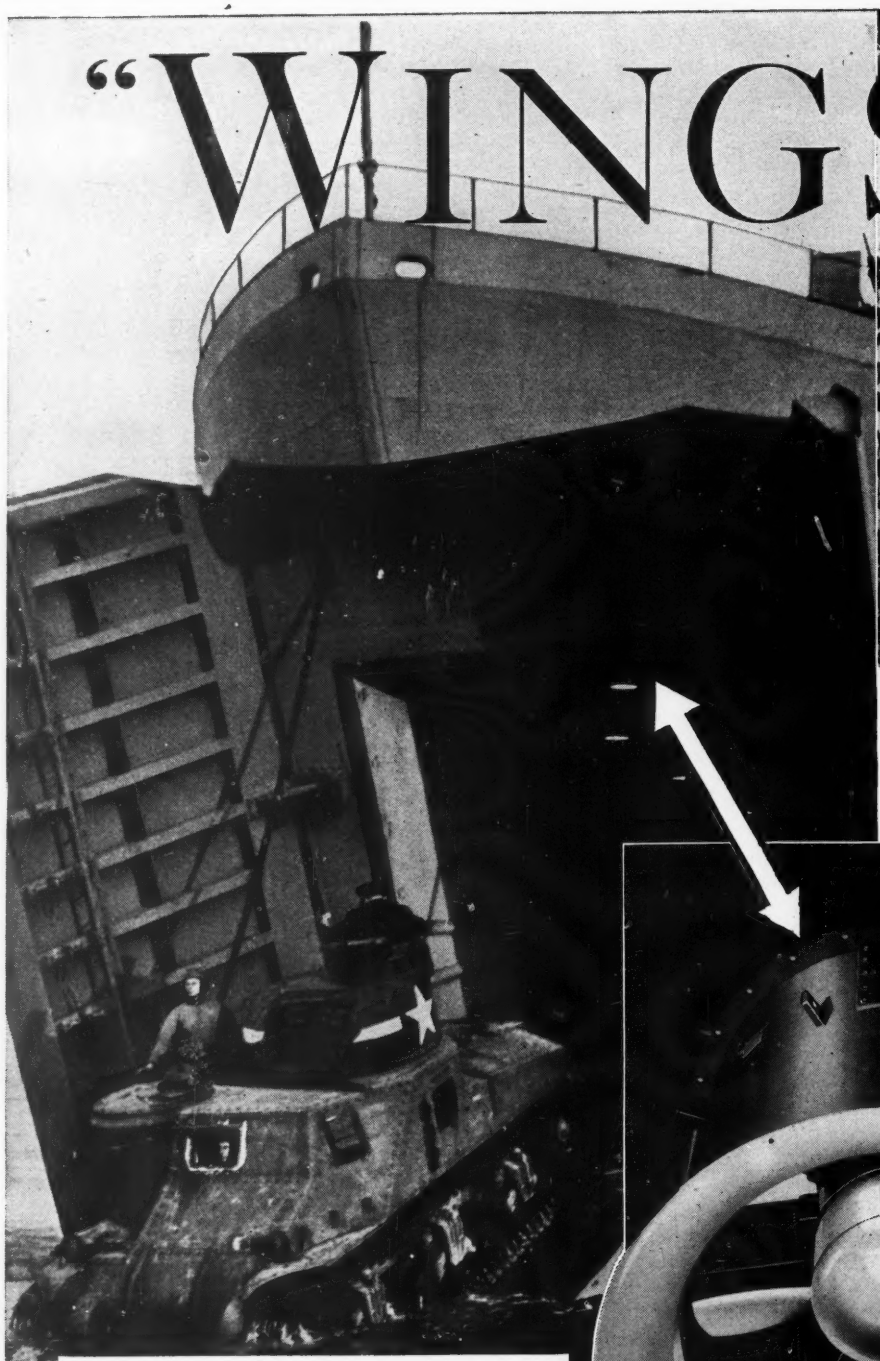
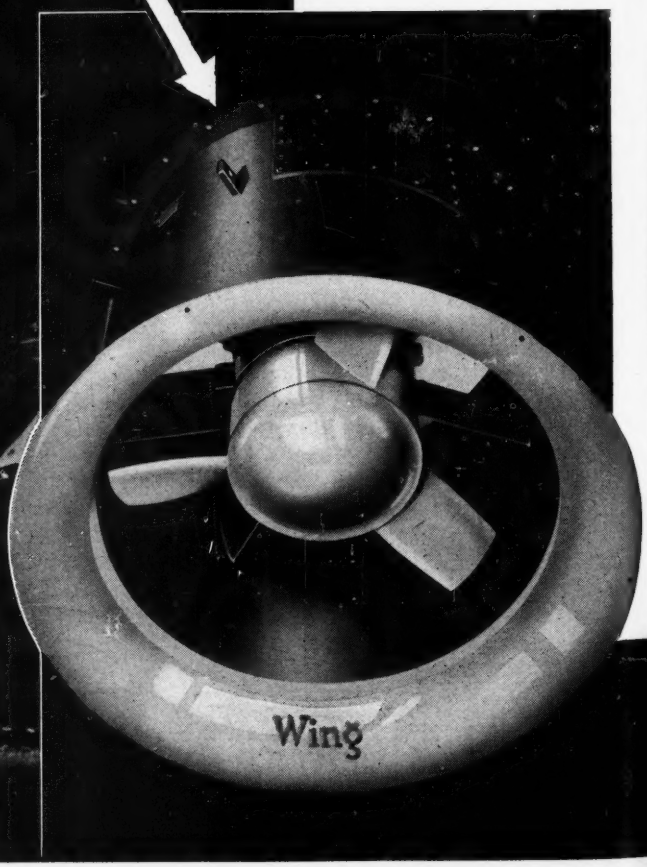
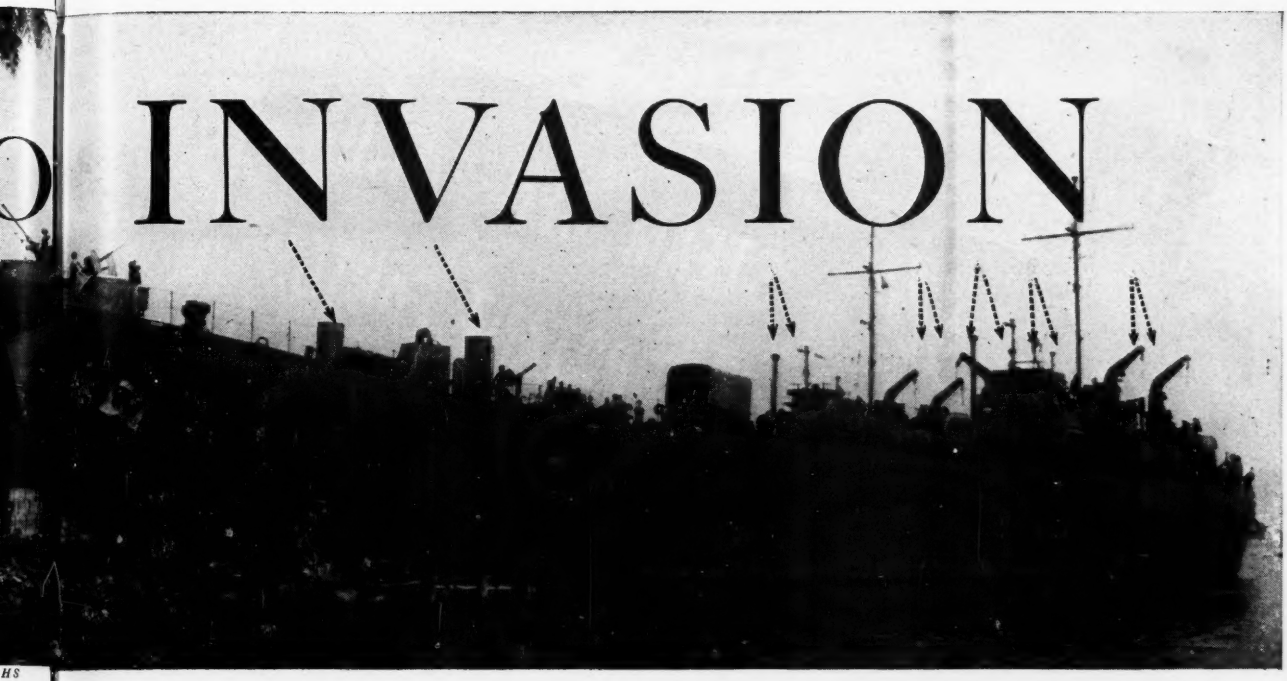
BY 750WI





"The inside of the tank decks of one of the LST's has the appearance of a gigantic garage, and, in fact, that is what it is. In the vast space there is row upon row of tanks, trucks and jeeps.

"These LST ships do not dock—they simply drive on to the beach until they ram the ground. Once beached, the ship has to stay there until all the cargo has roared its way ashore. Sometimes the work has to go on all night. Outside everything will be blacked out, while inside is a blaze of light, with the sound of engines starting up, the hum of the lift and the banging of caterpillar treads—and the traffic lights are shining from red to amber and amber to green. The deep hum of the exhaust fans can be heard as thousands of cubic feet of foul fumes are sucked out into the air. If those fans ever stopped, the soldiers working below would be dead in a few minutes."



CFM AT 1 INCH STATIC PRESSURE DISCHARGED WING AXIAL FLOW BLOWERS ON LST SHIPS

The first "cargo" discharged by the famous LST landing ships is the volume of deadly exhaust fumes given off by the tanks warming up below decks prior to the invasion landing. These fumes are exhausted through a large number of Wing Axial Flow Blowers each delivering 35,000 CFM at 1 inch static pressure. The "cargo" which follows is the world's most powerful armored corps—tanks, trucks, jeeps, motorized artillery — the vanguard of invasion blasting the way to Victory.

These LST's have made possible our successful landings in Tunisia, Sicily, the Italian Mainland, the Solomons, the Aleutians, and will undoubtedly be in the fore of the Invasion of the Mainland of Europe.

Wing is proud of the fact that its years of pioneering in the ventilation field have thus been climaxed by one of the most important ventilation projects of our time.

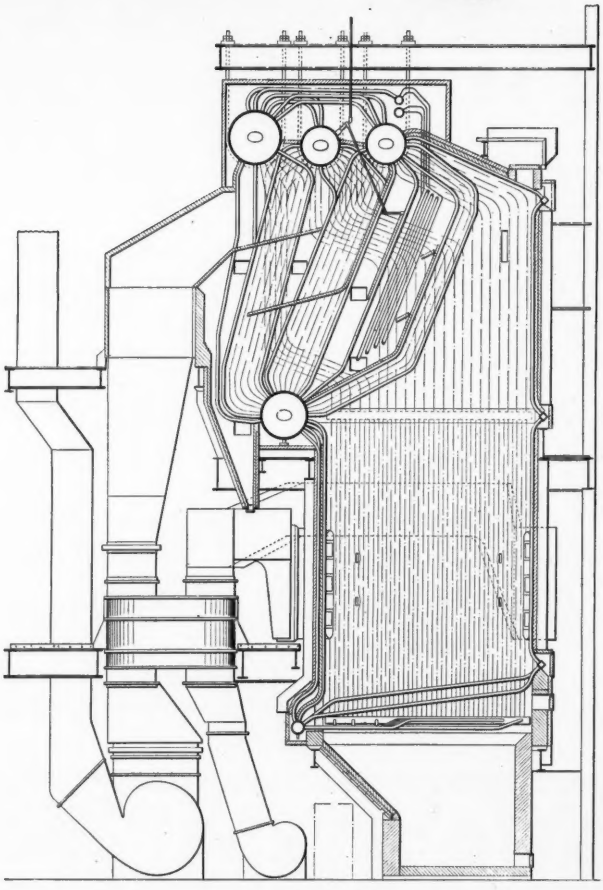
L. J. Wing Mfg. Co.

64 - 7th Avenue New York 11, N. Y.

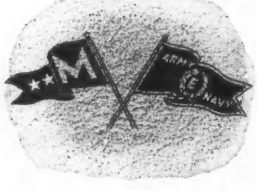
Factories: Newark, N. J. and Montreal, Canada

WING AXIAL FLOW BLOWERS

Reliable STEAM GENERATION PROVES an IMPORTANT FACTOR in a year of . . .



One of three identical C-E units installed in the boiler plant of a large steel mill. The capacity of each is 275,000 lb of steam per hr. Design pressure 550 psi. Total steam temperature 760° F. All are fired with blast furnace gas.



record-breaking

STEEL PRODUCTION

HERE'S an example of what reliable steam generation is contributing to the war effort expressed in terms of steel production. It's the record of the boiler plant in a large steel mill where three C-E steam generating units are installed. In a year of service, up to October, 1943, the combined use factor of the complete installation was 94.2%.

During this period the total output of the three units was approximately 5,000,000,000 lb of steam which establishes a use capacity factor of 76%. In other words, the three C-E units were called upon to produce the equivalent of ¾ of their maximum continuous hourly rating for the entire 12 months.

The response of this C-E equipment parallels the performance of many other C-E units in all types of war industries which are surpassing all previous concepts of production. Such a period of intensified operation serves to emphasize the factors of design and construction which are responsible for the reliable war-time performance of C-E steam generating equipment.

A-761

COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK, N. Y.

Combustion Engineering Corporation, Limited
Montreal · Toronto · Winnipeg · Vancouver

C-E

"FUEL CONSERVATION? THAT'S EASY!"

"This Engineered Instrumentation Helps Me to Maintain Production Schedules On Less Fuel"

★ "Fuel conservation through efficient combustion has always been one of my objectives, but now it is my patriotic duty as well.

"Every ton of coal, every barrel of oil, and every cubic foot of gas not burned in our boiler plants means that we have freed transportation facilities and manpower for other war activities.

"Engineered instrumentation makes it possible for us to conform with wartime conservation measures through increased efficiency rather than at the sacrifice of product output. There is more to engineered instrumentation than the purchase and installation of meters and controllers. It includes qualified, on-the-spot engineering advice regarding selection, application, installation, and adjustment of equipment to the particular requirements of your plant.

"To serve power engineers in this all-important phase of instrumentation, Bailey Meter Company maintains a staff of over 100 engineers who have been thoroughly trained in combustion and automatic control practice. They are located in over 30 industrial areas throughout the United States and Canada and are readily available to help you with problems of fuel conservation, power plant safety, continuity of operation, and boiler capacity. The Bailey Engineer not only helps to select and install suitable equipment, but he considers that his duty is not discharged until the equipment is in satisfactory operation and you are securing the desired results in the form of economies and improved performance.

"The Bailey Engineer in your community has a wide background of combustion engineering know-how at his command. It covers combustion tests on thousands of boiler installations including a wide range of fuels, furnaces, and fuel burning equipment. If you do not already know him, get acquainted at your next opportunity since he is a man who can help you with seasoned engineering service."

G-18-1

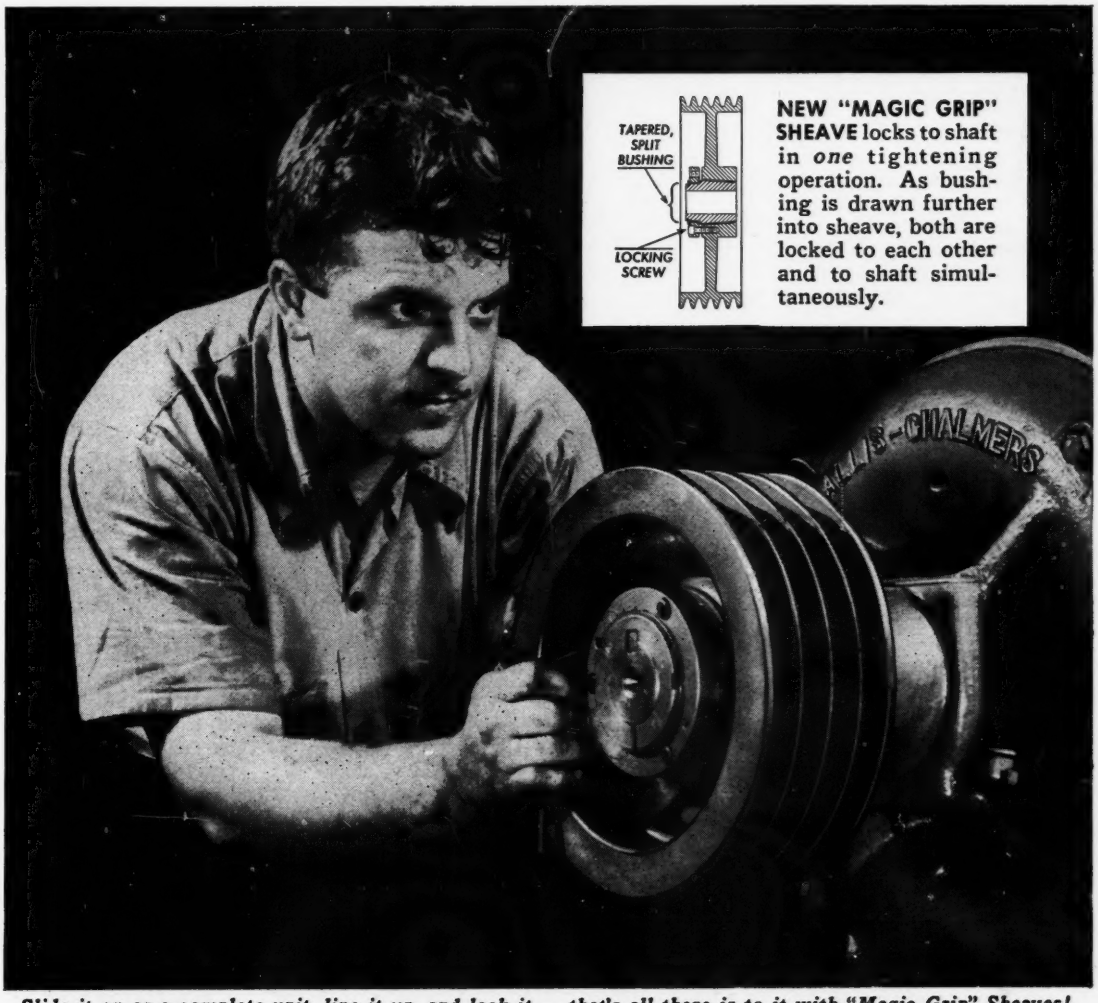
BAILEY METER COMPANY, 1040 Ivanhoe Rd., Cleveland 10, Ohio • Bailey Meter Company Ltd., Montreal, Canada

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

PRODUCT OF THE MONTH


TAPERED, SPLIT BUSHING
LOCKING SCREW
NEW "MAGIC GRIP" SHEAVE locks to shaft in *one* tightening operation. As bushing is drawn further into sheave, both are locked to each other and to shaft simultaneously.
ALLIS-CHALMERS

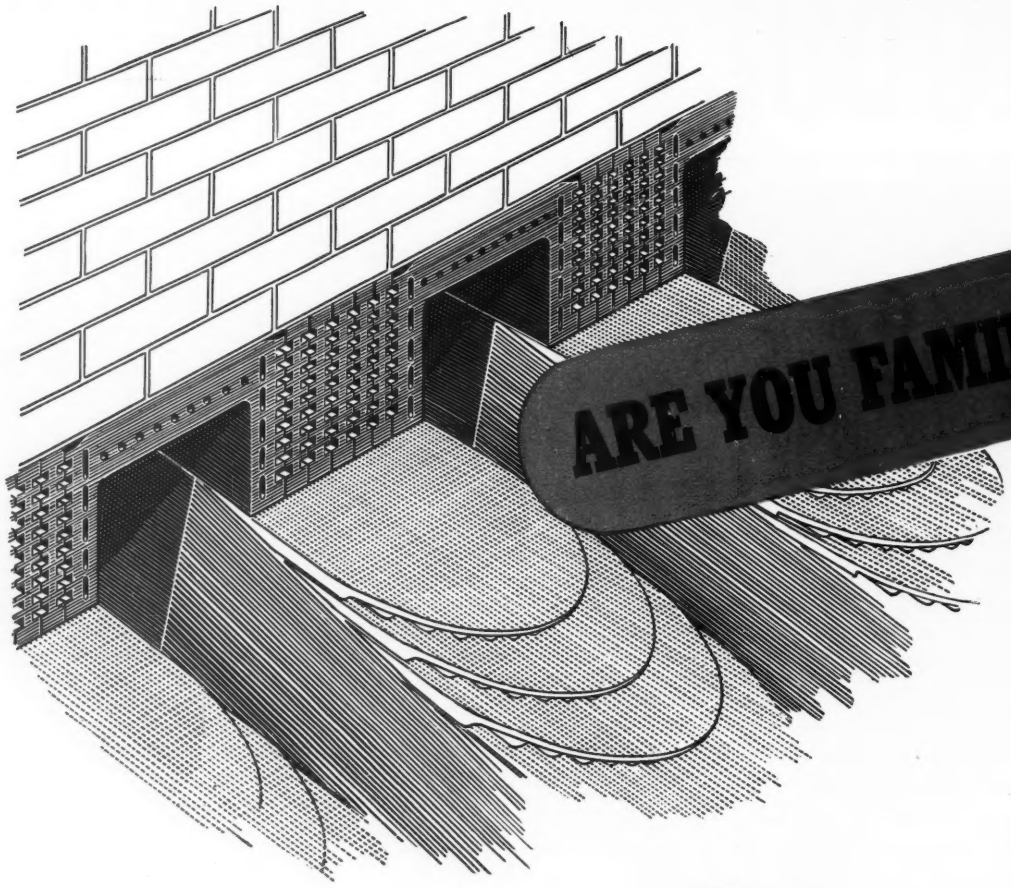
Slide it on as a complete unit, line it up, and lock it — that's all there is to it with "Magic Grip" Sheaves!

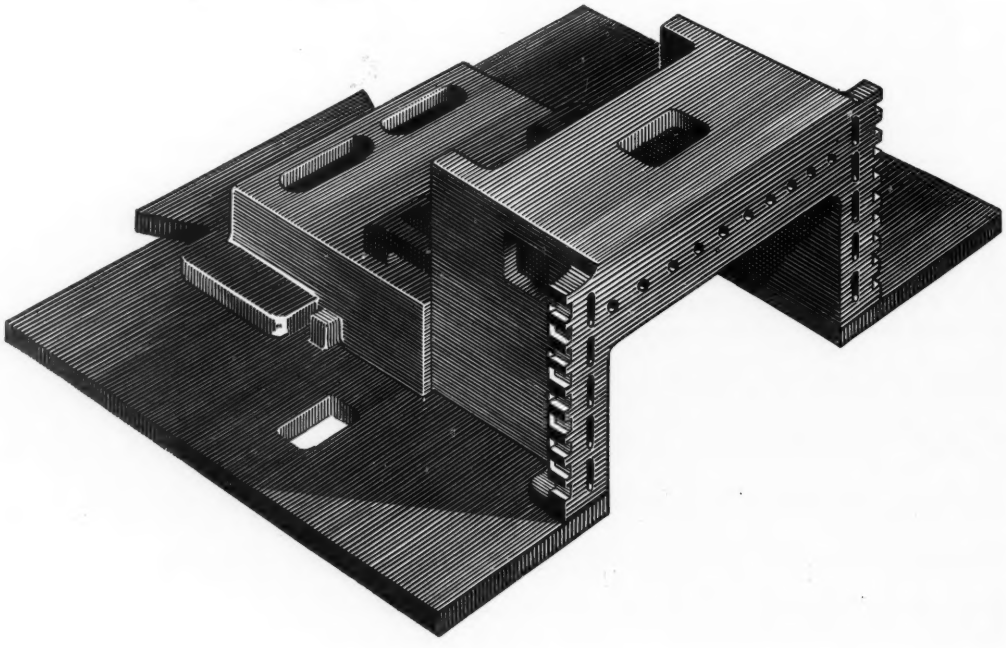
MILWAUKEE, WIS.—Allis-Chalmers announces the new "Magic Grip" Sheave . . . designed to save man-hours and money by going on or off faster than any other sheave on the market. New "Magic Grip" Sheave fits undersize or oversize shafts, centers perfectly, runs smoothly. Send for Bulletin B-6310.

A 1679

WE WORK FOR VICTORY — WE PLAN FOR PEACE

ALLIS-CHALMERS · MILWAUKEE · WISCONSIN


ARE YOU FAMILIAR



WITH ALL THESE FEATURES of the

FRONT WALL AIR BOX?

TAYLOR Front Wall Air Boxes and air cooled ram box caps work together to spread a screen of air across the stoker front wall. This action reduces clinker and slag formations, cuts labor and material costs of front wall maintenance, adds to operational freedom and efficiency.

The Front Wall Air Boxes and Air Cooled Ram Box Caps, like other features, add to the efficient, reliable, low cost operation of Taylor Stokers in generating steam.

Taylor air boxes and caps provide for lower costs in five other ways:

1. Replacements, easily made, are confined to short narrow vertical bars.
2. The Hi-Angle ram box cap provides for better packing of fuel at the mouth of the retort.
3. The cap improves the contour of the upper section of the fuel bed.
4. An air box bar is an integral part, on each side, of the ram box cap extension. This adds strength and permits the sides to be air cooled.
5. Two hooks which form a part of the ram box cap extension not only make it secure, but reduce the labor required for replacement.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. RELIABILITY—the ability to operate with minimum outage and minimum standby equipment.

2. CAPACITY—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.

3. MAINTENANCE—the ability to operate continuously with minimum repair costs.

4. FLEXIBILITY—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.

5. EFFICIENCY—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.

6. OPERATION—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.

7. ADAPTABILITY—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.

8. FUEL FLEXIBILITY—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.

9. REFUSE DISPOSAL—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.

10. STACK DISCHARGE—the practical elimination of "smoke nuisance" without special equipment.

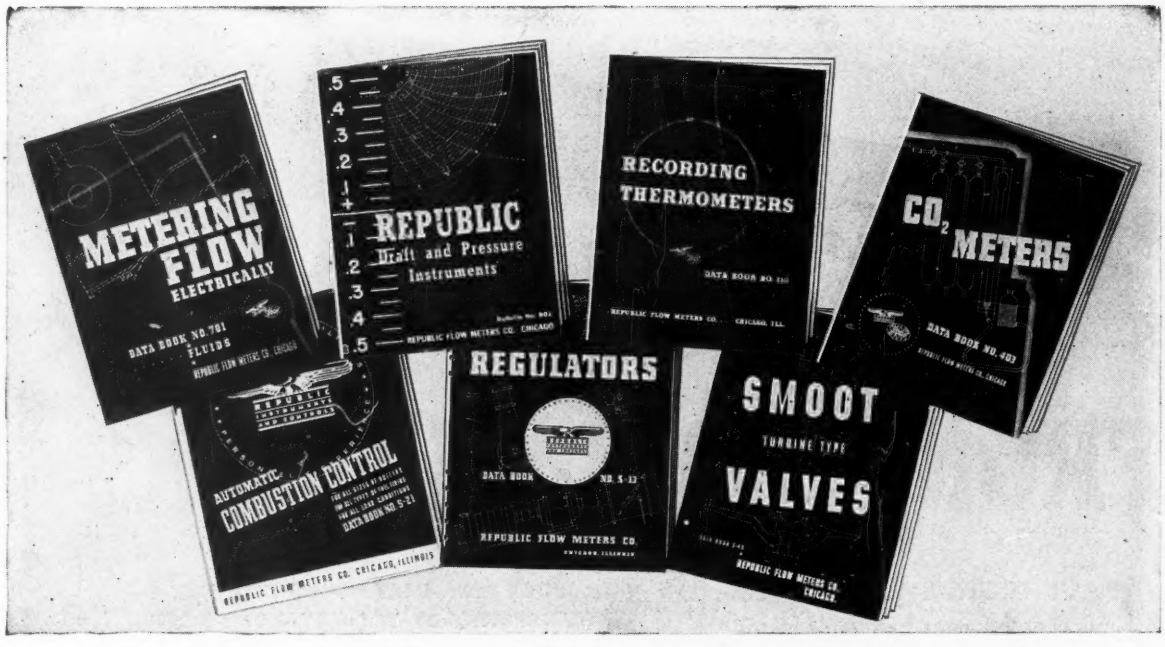
11. SPACE REQUIREMENTS—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.

12. OBSOLESCENCE—the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

A-E-CO TAYLOR STOKERS • LO-HED HOISTS
HELE-SHAW FLUID POWER • MARINE DECK AUXILIARIES

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25 • PENNSYLVANIA



These Data Books
WILL HELP YOU SOLVE YOUR POWER PROBLEMS

Write for these data books now! When your increased power load demands the installation of new units or the "stretching" of existing plant capacity, you will need this information.

REMOTE READING FLOW METERS—Data Book No. 701

For measuring flow of steam generated by each boiler and the total produced; steam consumed by prime movers and process steam consuming units; water supplied to boilers and pumped to processes; rate of generation, distribution and consumption of natural gas, coke oven gas, compressed air and the like; flow of fuel oil, brine, black liquor and so on; the Republic electrical type flow meter with remote reading instruments, as described in this book, is available.

MECHANICAL FLOW METERS—Bulletin No. 110

When it is desired to measure flow of steam, water, gas, air or oil for the same purposes as outlined above but where remote registration is not required, the Republic mechanical ring-balance meter described in this book is available. Since it may be built for differentials as low as 3 in. of water, it is ideal for low-pressure gas and air.

DRAFT AND PRESSURE INSTRUMENTS—Bulletin No. 801

Proper regulation of draft is one of the most important requirements in obtaining highest combustion efficiency. For indicating and recording drafts, pressures and differentials, Republic indicators and recorders, described in detail in this bulletin, are supplied in any desired combination for all ranges encountered in furnace operation.

RECORDING THERMOMETERS—Data Book No. 210

Measurements of temperature of flue gas, temperature in vats or tanks, pipe lines, refrigeration systems, ovens, kilns or ducts and so on, are vital in maintaining highest capacity and efficiency in power plant and process equipment. Republic recording thermometers for this service are described in this data book.

CO_2 METERS—Data Book No. 403

For every fuel and boiler, there is a definite percentage of CO_2 in the flue gas that will assure highest combustion efficiency. The CO_2 meter is the most practical method of determining combustion efficiency. The construction and operation of the Republic CO_2 meter are described in detail in this book.

REGULATORS—Data Book No. S-13

Control of rate of flow of liquids and gases, level of liquids, speed of turbines, engines and motors and proportions between variable pressures and flows must be accurate if maximum plant efficiency is to be attained. These factors are controlled by operation of valves, dampers, rheostats, etc. For sensitive, fast, stable and powerful automatic control of these devices, the Republic-Smoot regulator has been developed. Its construction, operation and applications are described in this book.

AUTOMATIC COMBUSTION CONTROLS—Data Book No. S-21

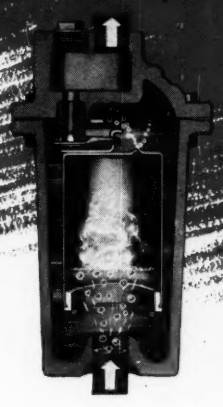
Boilers must produce maximum steam output at maximum efficiency. That means constant steam pressure, maximum combustion efficiency, constant and correct furnace draft, desired load division among boilers. Republic-Smoot automatic combustion control systems are built for all sizes of boilers, all types of fuel firing and all load conditions, as described in this book, which includes detailed installation reports giving performance data on outstanding power plants.

WRITE FOR THESE DATA BOOKS TODAY!

REPUBLIC FLOW METERS CO.

2224 Diversey Parkway, Chicago, Illinois

16 Armstrong traps save 800 gals. fuel oil per week in chemical plant



Armstrong traps on chlorobenzene stills in phenol plant.

FILE 5-41 Chemical plants represent another industry which uses thousands of Armstrong inverted-bucket steam traps to save fuel, money, heating time, maintenance and manpower.

A typical example from our files is that of a chemical manufacturer in Iowa, which effected a cut in fuel consumption from 1,500 to 700 gallons a week by the installation of 16 Armstrong traps. The savings in fuel are $2,500 a year. In addition, the management reported a reduction in boiler capacity requirements from 125 to 80 HP, and a definite increase in the efficiency of steam-heated kettles and other processing equipment as a result of proper trapping. Heating is faster and temperatures are more uniform and nearer theoretical pressure-temperature figures than formerly.

Some savings examples in other plants: Chemical company saves $25.00 per day with 17 Armstrong traps . . . one $29.00 trap saves $250 yearly in ammonia plant . . . coal requirements in insulator plant reduced from 5000 lbs. to 3000 lbs. per day.

In all industries, men who check their steam costs prefer Armstrong inverted-bucket traps

Armstrong traps get amazing results in all industries because of their principle of "complete" trapping. To get maximum return from the investment, it is necessary that the traps not only pass condensate as fast as it forms, without leakage of steam, but also eliminate air from the system and have the ability to handle all ordinary sludge and sediment. Armstrong traps do this through a combination of design features found in no other method of draining condensate. The patented free-floating valve and other engineering components insure freedom from wiredrawing in the valve orifice, permit holding tight against vacuum, and insure long life with negligible maintenance. In terms of hot condensate capacity, Armstrongs are very large in size and low in cost. Considerably over a million in use. Available in straight-through, angle and vertical piping styles, in all sizes and pressures.

Standard Armstrong traps, and special traps for air, water, gasoline and other services, are described and illustrated in the Armstrong Trap Book, which also contains valuable data on operation, installation and service. We'll be glad to send you a copy.

ARMSTRONG MACHINE WORKS

810 MAPLE STREET • THREE RIVERS, MICHIGAN

ARMSTRONG "INVERTED BUCKET" STEAM TRAP

Armstrong

HELP WANTED! TO SAVE A MILLION TONS OF PAPER

WAR uses up paper by the million tons.

Practically all of the 700,000 different items shipped to our soldiers overseas are wrapped in paper, boxed in paper containers, or both.

Paper protects weapons from dirt and rust.

Paper protects food.

Paper protects precious blood plasma.

And paper more and more takes the place of metals in war weapon manufacture. From plane gas tanks to gun mounts and explosives, paper solves war production problems.

What does this mean to you?

It means you must join Uncle Sam in a nation-wide drive to conserve paper, to insure our boys getting the paper they need to fight this war.

How do you conserve paper?

You make each piece stretch. You get as much use as possible out of each piece, then you save it for the scrap paper drive.

You help your storekeeper save paper by not asking for useless wrapping. You save paper bags by carrying a shopping basket or by using bags again and again until they are worn out.

You help the manufacturer of your home needs to save paper. How?

By accepting his new wartime simplified packaging. You judge his products on their worth to you, not on the beauty, yes, or even the convenience of their containers.

In short, you treat paper as the precious war material it truly is.

And you help save 1,000,000 tons for the war effort.

An easy job. You bet. And one of the most important ones you can do for Uncle Sam and the boys who are doing the fighting.

★ ★ ★

This Space Contributed By POWER PLANT ENGINEERING

STARTING JANUARY 18TH

IT'S UP TO YOU!

STARTING January 18th, it's up to you to lead the men and women working in your plant to do themselves proud by helping to put over the 4th War Loan.

Your Government picks you for this job because you are better fitted than anyone else to know what your employees can and should do—and you're their natural leader. This time, your Government asks your plant to meet a definite quota—and to break it, *plenty!*

If your plant quota has not yet been set, get in touch now with your State Chairman of the War Finance Committee.

To meet your plant quota, will mean that you will have to hold your present Pay-Roll Deduction Plan payments at their peak figure—*and then get at least an average of one EXTRA $100 bond from every worker!*

That's where your leadership comes in—and the leadership of every one of your associates, from plant superintendent to foreman! It's your job to see that your fellow workers are sold the finest investment in the world. To see that they buy their share of tomorrow—of Victory!

That won't prove difficult, if you organize for it. Set up your own campaign right now—and don't aim for anything less than a 100% record in those *extra* $100 bonds!

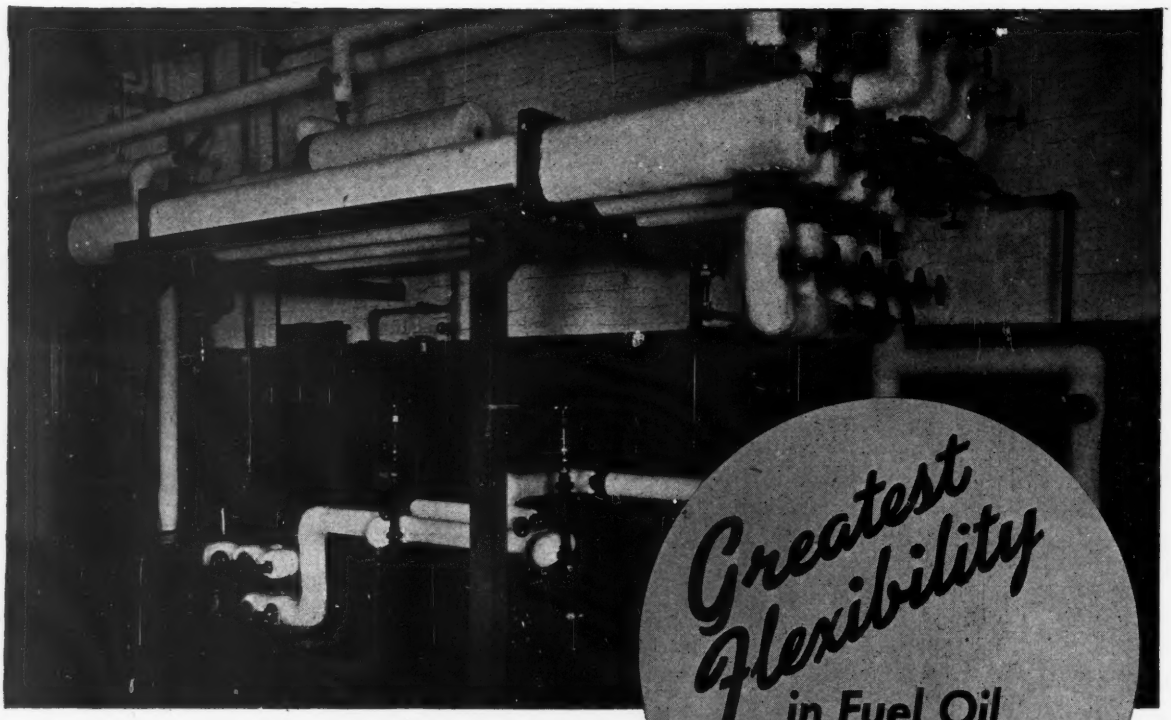
And here's one last thought. Forget you ever heard of "10%" as a measure of a reasonable investment in War Bonds under the Pay-Roll Deduction Plan. Today, thousands of families that formerly depended upon a single wage earner now enjoy the earnings of several. In such cases, 10% or 15% represents but a paltry fraction of an investment which should reach 25%, 50%, or more!

Now then—Up and At Them!

Keep Backing the Attack!—WITH WAR BONDS

This space contributed to Victory by Power Plant Engineering

This advertisement prepared under the auspices of the United States Treasury Department and the War Advertising Council



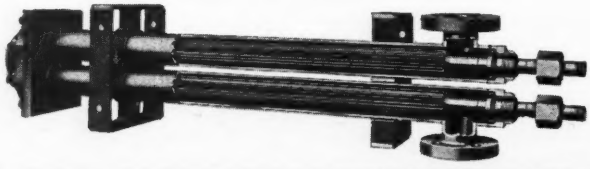
Greatest Flexibility in Fuel Oil Heating Installations

TWIN G-FIN SECTIONS...

These standard, interchangeable, compact heating units can be placed wherever convenient . . . connected in series or parallel for desired capacity and heating effect.

Individual units can be cut in and out of the line to maintain constant oil temperature at fractional loads . . . unused units can be inspected or cleaned without shutting down the entire heater installation . . . these are some of the reasons why TWIN G-FIN SECTIONS give GREATEST FLEXIBILITY in fuel-oil heating installations.

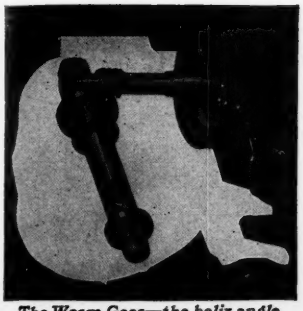
Write for Bulletin



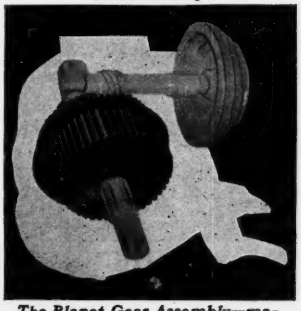
The Griscom-Russell Co.
285 Madison Avenue
New York 17, N.Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

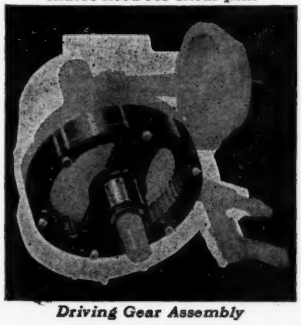


The Worm Gear—the helix angle used obtains maximum mechanical efficiency.



The Planet Gear Assembly—materially reduces tooth-load which ordinarily causes rapid wear.

Back Ring Gear, with Locked Screw Safety Release which eliminates need for shear pin.



Driving Gear Assembly

TAKE IT APART!

...SEE WHY THE WINKLER STOKER HAS THE ONLY FULLY *AUTOMATIC* TRANSMISSION!

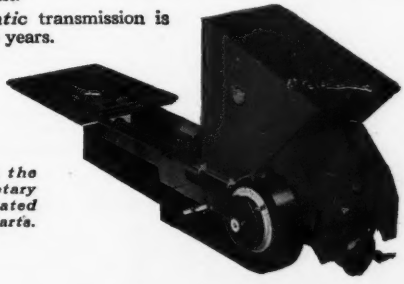
Judgment of a stoker's merit inevitably centers on its transmission. Critical examination and comparison of the Winkler Stoker Transmission will reveal designs and constructions which appeal to your sense of good engineering.

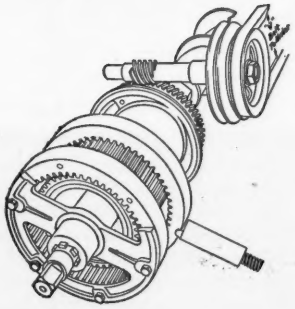
You will see how the mechanical advantages of internal ***planetary gearing*** are employed to develop a smooth flow of extraordinary power. The practical value of ***extra power*** is made evident by the fact that the Winkler Stoker is not stalled by, but ***crushes*** the usual obstructions which may occur in the coal pile.

NO SHEAR PIN!

Uncrushable or metallic obstructions are handled by the Winkler Safety Release—an exclusive feature built into the Transmission. This device automatically and continuously disengages the motor from the transmission and resets it again until the blocking object is removed. Both motor and mechanism are thus protected against overload ***without need for a shear pin!***

This ***fully automatic*** transmission is guaranteed for three years.





This sketch shows the Winkler Inter-planetary Transmission separated into its component parts.

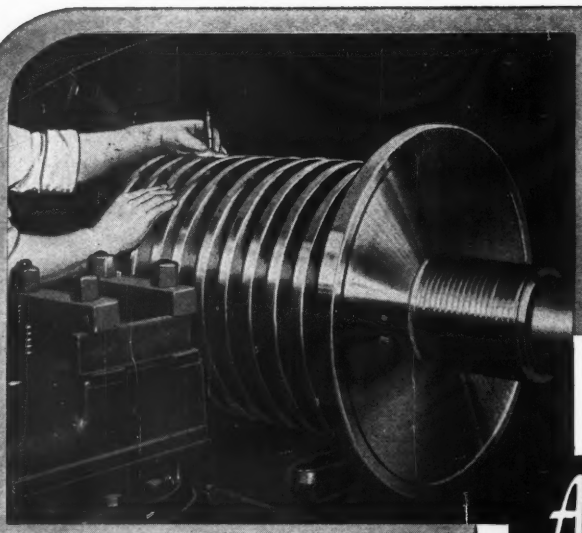
FREE BOOKLET

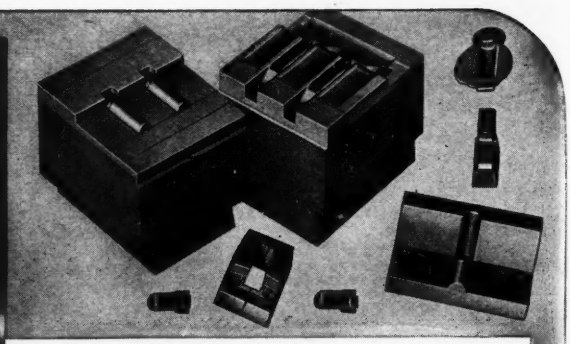
The Winkler Engineering Department has published an interesting brochure on the mechanics of inter-planetary gearing as applied to Winkler Stokers. Your request for a copy will be promptly honored.

WINKLER

fully automatic STOKERS

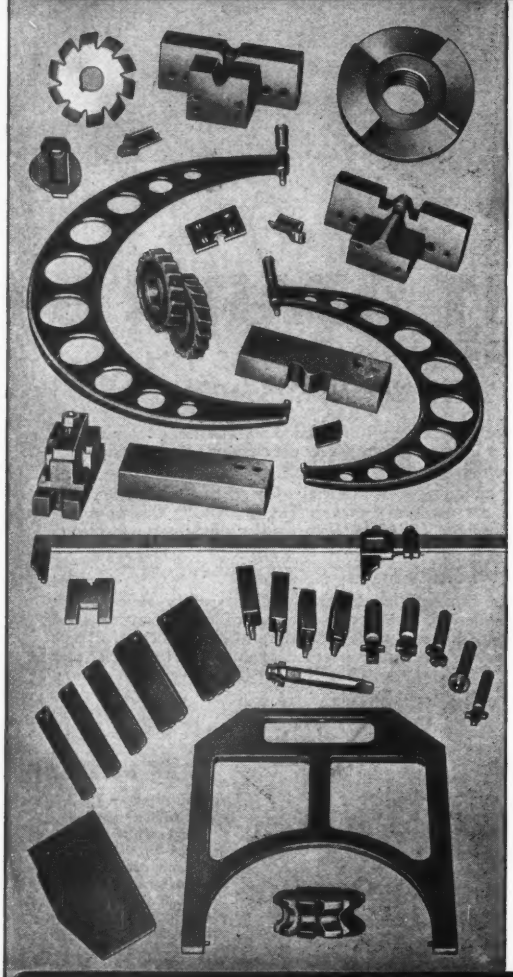
U. S. MACHINE CORPORATION, LEBANON, INDIANA





Special tools, gages, jigs and templates used in the production of the integral steam turbine rotor shown.

A Manufacturing Policy THAT HAS STOOD THE TEST OF TIME



From its inception in 1901, the De Laval Steam Turbine Company has recognized that the best results are obtainable only by confining the work of its staff to the development, design and production of a single class of manufacture, having the same general characteristics and requiring the same processes and high grade of workmanship. Consequently the efforts of the company have been confined to high-speed rotary power equipment, including STEAM TURBINES, HELICAL and WORM SPEED REDUCING GEARS, CENTRIFUGAL PUMPS and COMPRESSORS and ROTARY OIL PUMPS.

The jigs, tools and gages required for the production of high-grade work are much more expensive and elaborate than are those necessary for work requiring less refinement and care in manufacture. Also, the type of shop employee who can perform this accurate work is entirely different from that required for less particular and accurate classes of work.

M-29

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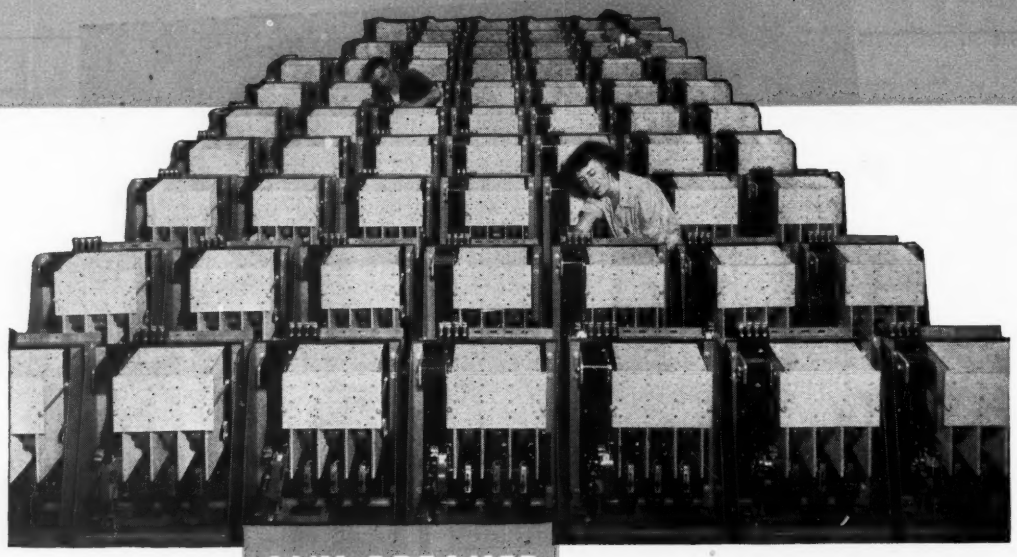
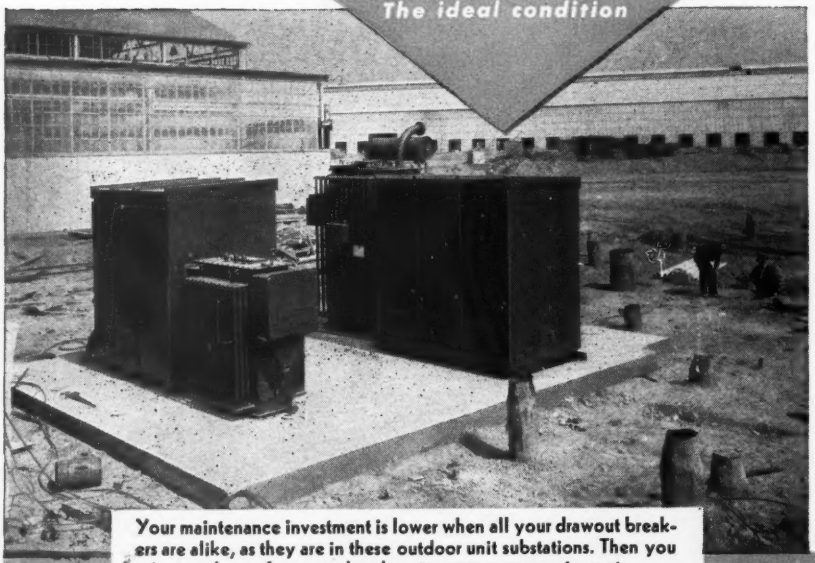


ANY BREAKER FITS IN ANY HOUSING

The ideal condition

Interchangeable, drawout air circuit breakers afford a high degree of power-service continuity. Every breaker is electrically, mechanically, and thermally co-ordinated for proper operation.

Drawout air circuit breakers help boost your production because they are conservatively rated and easy to operate. You should have fewer and shorter power interruptions after you install drawout-breaker equipments.



Your maintenance investment is lower when all your drawout breakers are alike, as they are in these outdoor unit substations. Then you need very few spare breakers to serve many equipments.

PACKAGED SWITCHGEAR

Every week 102,000 G-E employees purchase more than a million dollars' worth of War Bonds.

EVERY WORKING DAY
DRAWOUT-BREAKER EQUIPMENTS
to protect power circuits of 600 volts and below

How you add working minutes

By reducing time lost after power interruptions. To restore service, you simply turn the breaker handle. Or—if breakers are *electrically operated*—push a button.

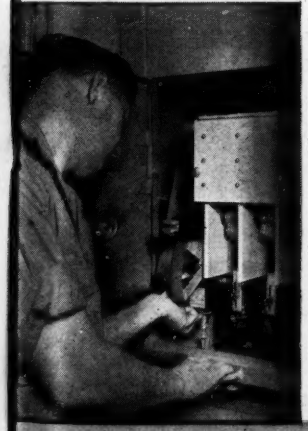
By reducing inspection time. You can inspect a drawout air circuit breaker in less than two minutes. In the inspection position, the breaker is easily accessible, disconnected from live parts. One man often can inspect all the breakers in a medium-size equipment during a lunch period.

By reducing maintenance time. Long shutdowns for maintenance are unnecessary, because drawout breakers are interchangeable. Any breaker can be replaced by any spare of the same type and rating. This permits immediate restoration of service, and maintenance of breakers at your convenience.

Drawout breaker equipments have proved so popular that we build them on a mass-production line. You get, with a saving in cost, the best breakers we know how to build. For more information, write for Bulletin GEA-2596. *General Electric Company, Schenectady, N. Y.*

Your workers quickly become familiar with both indoor equipment (shown here) and outdoor equipment, because the breakers are the same in both. This makes training of maintenance men easier.

During routine maintenance, you save many hours of time.



Inspect as usual. Then, if necessary, lift breaker out, put

in a spare, and restore power. The breaker that you removed

goes first to the maintenance shop, and then joins the spares.

GENERAL ELECTRIC

GET THAT UNIT BACK

WHEN condenser trouble makes shut-down of a vitally needed unit imminent and unavoidable—it's *a job for specialists.* Call Conseco, and schedule a rush job — between peaks if possible.

In a short time after actual shut-down, with our special hydro-dynamic shock test, we can tell you how many bad tubes you have. If the number is small, and plugging will get you by for a reasonable length of time, we'll give you the good news and have you back in service *pronto.*

If the percentage of weak tubes is seriously high, we'll tell you that, too, and give you a report on what has to be done, and how *fast* we can do it — and we mean *FAST.*

Where retubing is found to be necessary, we can usually complete the job in one off-peak down — because we are specialists and because we have the know-how, the facilities and often the materials.

For fifteen years, now, we have been servicing condensers and heat exchangers for utilities and industrial power plants throughout the nation. During this time we have developed our own time-saving tools and methods to give you a better, faster job. Today we are operating on a clock-around schedule — *Emergency Service* is our normal business. Don't hesitate to call us any hour of the day or night.

Condenser Service
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1-CS-3

Sectional header...

CROSS-DRUM BOILER

...meets wide range of local conditions

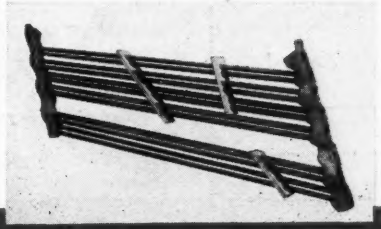
THE sectional header, cross drum boiler, as designed and built by Springfield is widely favored for manufacturing plants as well as central station use.

One reason for this is that the Springfield variation of this type of boiler is flexible enough to be economically adapted to a wide range of fuels, water, space, load, and other local conditions.

Operating reports, on a wide range of fuels, show that Springfield units develop unusually high efficiencies as proved by low exit gas temperatures; through using smaller tubes, staggered tube groupings, permanently tight baffle construction, and well integrated overall design.

"Less outage for maintenance" is a common comment on Springfield installations. Controlled circulation with delivery to the steam drum above the water level gives this boiler ability to produce dry steam and handle rapidly changing loads. Water conditions should be carefully controlled in any modern boiler plant but this type of boiler is less sensitive and affords additional protection when water conditioning "slips". Larger and fewer handhole openings reduce the time and cost of cleaning, inspection and repair. Soot and ash cannot lodge on headers and drums. All parts are readily accessible.

In replacing obsolete boilers, it is often desirable to install larger capacity units without extensive building changes. Springfield boilers are lighter and more compact than other designs, and are readily adaptable to restricted space requirements. Pitch of tubes may be varied from 15 to 25 degrees to suit local conditions. High capacity water walls increase furnace capacities.



Because of factory assembled sections and single drum construction, from 30 to 60 days are saved on erection time. Less brickwork is required, and cross tube baffles are delivered in place. Complete drawings and patterns are available to produce duplicate units of many of the great number of modern Springfield generating plants built in recent years.

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Springfield boiler installations range from 5,000 to 450,000 lbs. per hour capacity; and from 75 to 750 psi pressure. Contracts taken for complete steam generating units. Write for information. **SPRINGFIELD BOILER CO., 1951 E. Capitol Ave., Springfield, Ill.**

SPRINGFIELD

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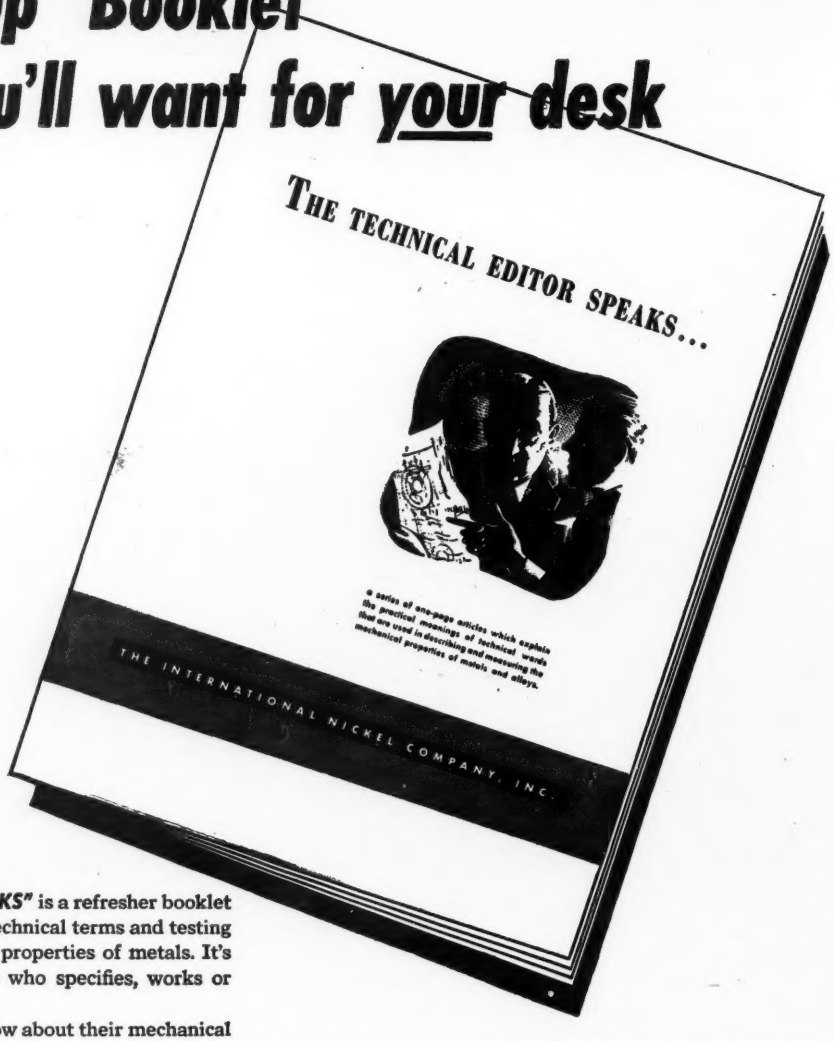
SPRINGFIELD BOILERS

ANY SIZE
ANY FUEL
ANY PRESSURE

A "Brush-Up" Booklet you'll want for your desk


THE TECHNICAL EDITOR SPEAKS...
a series of one-page articles which explain the practical meanings of technical words that are used in describing and measuring the mechanical properties of metals and alloys.
THE INTERNATIONAL NICKEL COMPANY, INC.

"THE TECHNICAL EDITOR SPEAKS" is a refresher booklet that brings you up-to-date on the technical terms and testing procedures used in measuring the properties of metals. It's a handy, useful guide for anyone who specifies, works or uses metals.

It tells you what you want to know about their mechanical properties . . . how they are determined and how the information is used to judge metals for practical applications. Compiled from a series of articles written by THE DEVELOPMENT and RESEARCH DIVISION of THE INTERNATIONAL NICKEL COMPANY . . . it includes discussions and descriptions of the properties listed below. Send for a complimentary copy today.

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Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

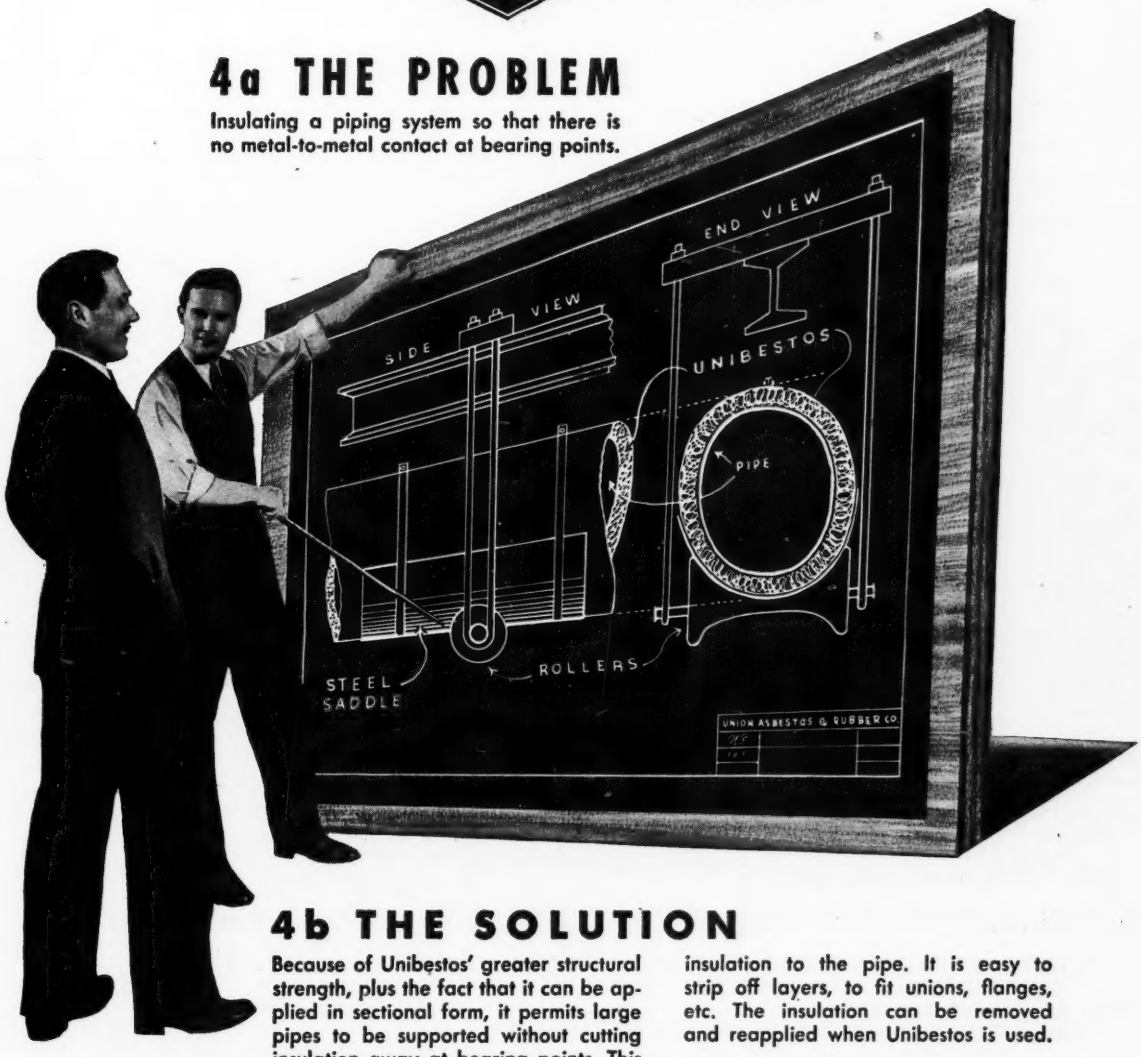
This is the 4TH in a series of messages

DEALING WITH THE PROBLEMS IN HEAT INSULATION FACED BY ENGINEERS AND SOLVED BY USING

UNARCO unibestos

4a THE PROBLEM

Insulating a piping system so that there is no metal-to-metal contact at bearing points.



4b THE SOLUTION

Because of Unibestos' greater structural strength, plus the fact that it can be applied in sectional form, it permits large pipes to be supported without cutting insulation away at bearing points. This is done by laying a steel saddle under the insulation at points where the pipe is supported by rollers, tie rods or other means. This makes it unnecessary to cut away the insulation or to use metal supports that penetrate through the insulation to the pipe. It is easy to strip off layers, to fit unions, flanges, etc. The insulation can be removed and reapplied when Unibestos is used.

unibestos is available in Standard material, for temperatures up to 750°; Super, with a temperature limit of 1200°; Combination, with a temperature limit of 1200°. These temperature limits permit the use of one material at maximum efficiency for a wide range of purposes. Unibestos is available in half sections up to 30" pipe diameter and from 32" to 60" in quadrants from ¾" to 5" in thickness. Standard and Super are available in single layer construction with provision for expansion in piping, where required.

TWO ARMY-NAVY "E" AWARDS FOR EXCELLENCE IN WAR PRODUCTION ONE TO THE CICERO, ILLINOIS PLANT, ONE TO THE PATERSON, N. J. PLANT.

UNION ASBESTOS & RUBBER CO.

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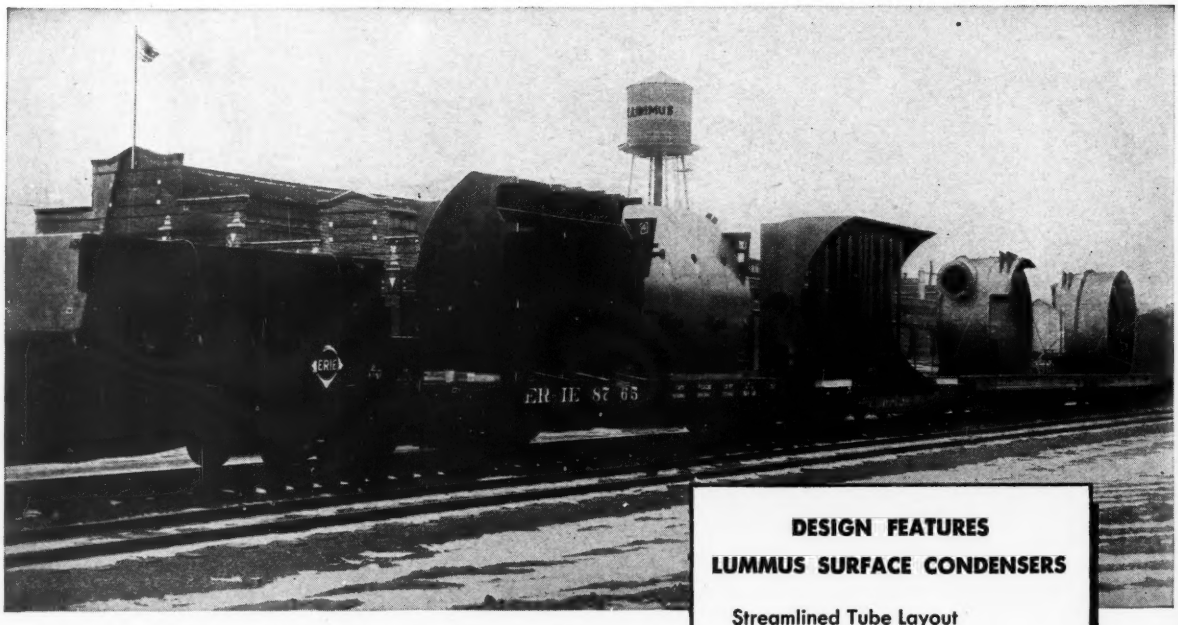
ONE of FOUR

Surface Condensers
Totaling 122,000 Square Feet



Typical of larger surface condensers designed and built by Lummus is this 36,000 square foot unit for a well-known public utility. Precision workmanship in the Lummus Company plant will facilitate easy and accurate assembly in the field.

All Lummus condensers are equipped with air ejectors designed and built by Lummus.

DESIGN FEATURES
LUMMUS SURFACE CONDENSERS

Streamlined Tube Layout
Internal Air Cooling Section
Deaerating Hotwell

RESULTING IN —

Minimum Pressure Drop
Minimum Condensate Depression
Minimum Condensate Oxygen Content
Minimum Air Ejector Steam Requirements

THE LUMMUS COMPANY · 420 LEXINGTON AVE., NEW YORK, N.Y.

LUMMUS

A LESSON IN WATER COOLING

LESSON 10 OF A SERIES

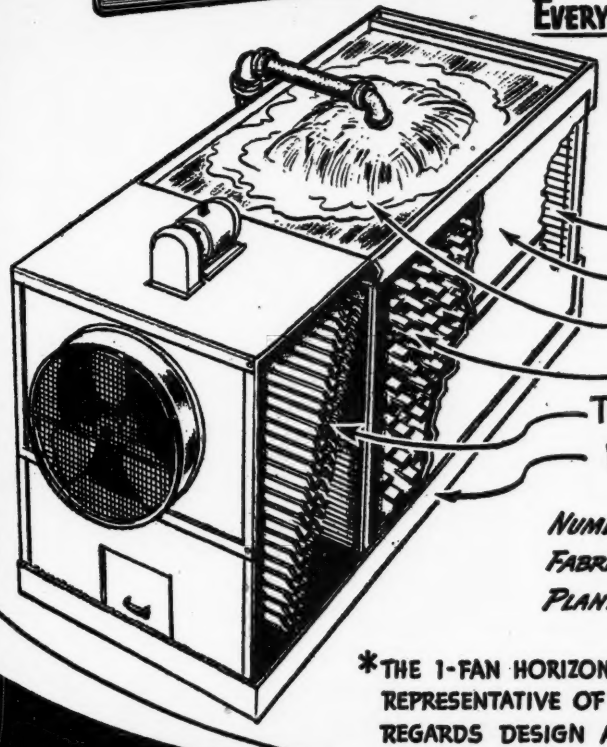
DESIGN AND CONSTRUCTION OF WOODEN PARTS

Wood is utilized more than any other material in the construction of present-day water cooling towers. The selection of the right kind and grade of lumber therefore is of great importance. The *proper* designing, fabricating and framing of this lumber into parts, however, is not only important but imperative if the tower as a whole is to function most effectively and have a long, trouble-free life with a minimum of maintenance and operating care.

The perfections and additional cost incorporated into the wooden parts of a cooling tower (or the lack of them) are easily overlooked and seldom given due consideration by the purchasers of this equipment. It is into these parts that the manufacturer soundly builds quality and long life—or may omit them without necessarily affecting cooling performance *within the guarantee period.*

In addition to the main framing, the wooden parts of a cooling tower consist essentially of the casing, the filling, the inlet louvers, the drift eliminators, the distribution system, the water basins, and the fan decks with housings. The alternate conditions of wet and dry, hot and cold plus the severe mechanical and structural demands that constitute cooling tower service do not only call for lumber of excellent grade but also for manufacturing skill and experience of high order. The following specifications can be used to check and measure the correctness of design, the quality of workmanship and the proper construction of these parts.

1. Nails eliminated wherever possible.
2. Provision is to be made for the expansion and contraction of the lumber, and in such a manner as not to impair the function or efficiency of the part.
3. Parts and pieces are to be securely held in place and alignment by the proper type and spacing of supports or fastenings.
4. Parts are to be accessible for inspection and, where desirable, easily removable.
5. Designs and construction shall preferably be pre-tested by field service.
6. Parts shall be shop fabricated and standardized methods employed.
7. All parts shall be of sufficient size as to guarantee proper structural strength for the loads and service imposed.
8. Proper type and grade of lumber shall be selected for the service required of the particular part.



EVERY WOOD PART IN EVERY MARLEY TOWER* MEETS THE RIGID SPECIFICATIONS ABOVE

EACH INVITES DETAILED INSPECTION AND COMPARISON:

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- DOUBLE-WALL CASING, PANEL UNITS
- EXTERNAL WATER DISTRIBUTION
- MORTIS LOCKED NAIL-LESS FILLING
- THREE-PASS NAIL-LESS DRIFT ELIMINATORS
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*THE 1-FAN HORIZONTAL INDUCED DRAFT TOWER PICTURED HERE IS REPRESENTATIVE OF ALL TYPES AND SIZES OF MARLEY TOWERS AS REGARDS DESIGN AND ADVANTAGES OF WOOD PARTS.

MARLEY COOLING TOWERS

THE MARLEY COMPANY INC.
KANSAS CITY, KANSAS

A Sweet Trapping Job by YARWAYS

Efficient Trapping Permits Close Temperature Control ... Vital in Candy Making

MINTER BROTHERS, Philadelphia, makers of delicious fudge, marshmallow and caramel, are standardizing on Yarway Impulse Traps for all their Trapping Jobs.

The reason in a nutshell: "Yarway's continuous discharge on heavy condensate loads and intermittent discharge on light loads, keep steam lines and Kettle Jackets drained, permitting accurate temperature control."

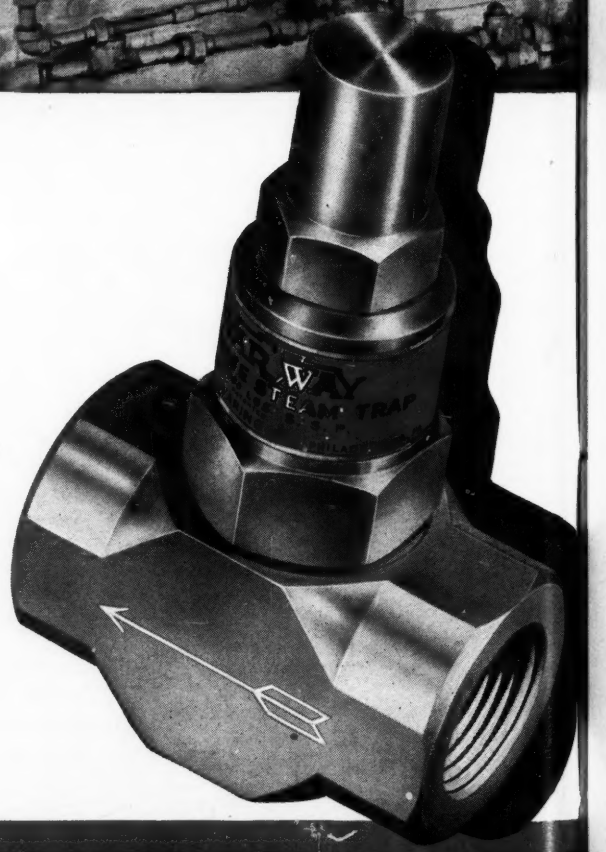
More Than 250,000 Yarways Have Been Purchased

Yarway Trap performance talks. *Quicker heating and greater sustained heating efficiency* soon pay for the installation and continue to return worthwhile profits in plant operating economy. When you consider that their *purchase price* is usually *no more than the cost of repairing an ordinary trap* —why not get Yarway performance for your money?

Then, too, its *small size saves space.* Its *light weight simplifies installation.* Its unique design with *only one moving part* and its *rugged bar-stock construction,* keep down maintenance expense. And Yarway Traps are *suitable for wide range of pressures without change of valve or seat.*

A nearby Mill Supply Dealer handles YARWAY IMPULSE TRAPS and will be glad to serve you. Or write for Catalog T-1738.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.



YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

The Future of Engineering Education

By KARL T. COMPTON

AMONG THE conclusions which we might draw from the things that Dean Hammond has said about the past of engineering education, these points seem to me important. One is the the differentiation between two very important aspects of the general field in which we are interested will continue, and I believe will continue to grow in differentiation. I refer to the differentiation between the empirical, practical art on the one hand; the scientific or analytical approach to practical problems on the other hand. Both are extremely necessary, both are fields of concern to us.

Another tendency of the past which I believe will increase is the tendency to build up our engineering staffs as coordinated teams, with heavy centers and nimble quarterbacks and so on, drawing not only from the field of the particular branch of engineering, but occasionally drawing in a physicist, a chemist, or a mathematician, to make him a working member of the group in building up an effective department of engineering.

Coming now to the effect of some of the current forces on the trend in engineering education, Dean Potter has already mentioned some new engineering fields—not new basic fields but new curricula which may be superimposed upon some of our others. He mentioned the electronics field and the high-frequency field, to which I would add some new practical applications in the field of air dynamics and some very important new applications of thermodynamics coming in as a result of some of the developments of the war.

One point that has interested me a great deal has been the interaction between the scientists on the one hand and the engineers on the other in their joint problem of trying to get new devices developed and put into production. I have been very much struck by the fact that the professional scientist, on the whole—and, of course, there are many exceptions—is a better bet than the professional engineer in an attempt to solve a distinctly new problem which is not in a conventional field.

Our engineering education has not been as progressive in developing the research side as it has in developing the side of the practical application of the more conventional arts; it has done the latter in a decidedly effective way.

I don't know how important this research side is to the engineer. It is very important to society that attention be given to it. If it is not given by the engineer, it will be given by other groups. It will be given always by scientists.

One group—the practicing engineers, construction engineers, industrial engineers, sales engineers—is of a type which can be given good preliminary training by the conventional four-year engineering program, sometimes with the fifth year added, and on top of that a great deal of practical experience in the field; then if the engineer has the inherent qualifications in his own makeup he can grow to do those jobs very effectively.

There is the other type of engineer, in which I might include the design engineer and the research engineer, for whom the above type of training is not adequate and is not comparable with the type of training which the professional scientist is now getting to do his job of handling new types of problems.

One other fact has occurred to me frequently as I have followed some of the current experiences in the development of new devices of the war, and which I might express by the phrase "the hazards of long established competence."

Suppose there is a group of companies that makes some kind of a machine which has quite a scientific background; there has been a lot of background, art and science in its development. There may be three or four companies to which everybody would look as the first groups in the country—perhaps the only groups—to carry through some desirable development. It may be important, for example, to get a machine that will be ten times more efficient in output per weight, or even one hundred times more efficient in output per weight or output of product per power. Too frequently in this war effort, firms in that category have been approached with such problems, with the result that their research engineers, research departments and sales departments have united in saying the thing can't be done, and have shown reasons why it could not be done; have shown how this thing had been tried years ago and, they feel, thoroughly explored. They feel that there is no use in exploring the matter again; they have not enough interest to take a contract to tackle it; they are complacently confident that they are "the last word" on the subject.

Then some group of competent engineers and scientists get together from some other environment, go at the thing afresh and actually bring about a 17-fold increase of efficiency in output per weight of equipment and a comparable increase in efficiency of output per power. I know of at least three instances in which that sort of thing has happened.

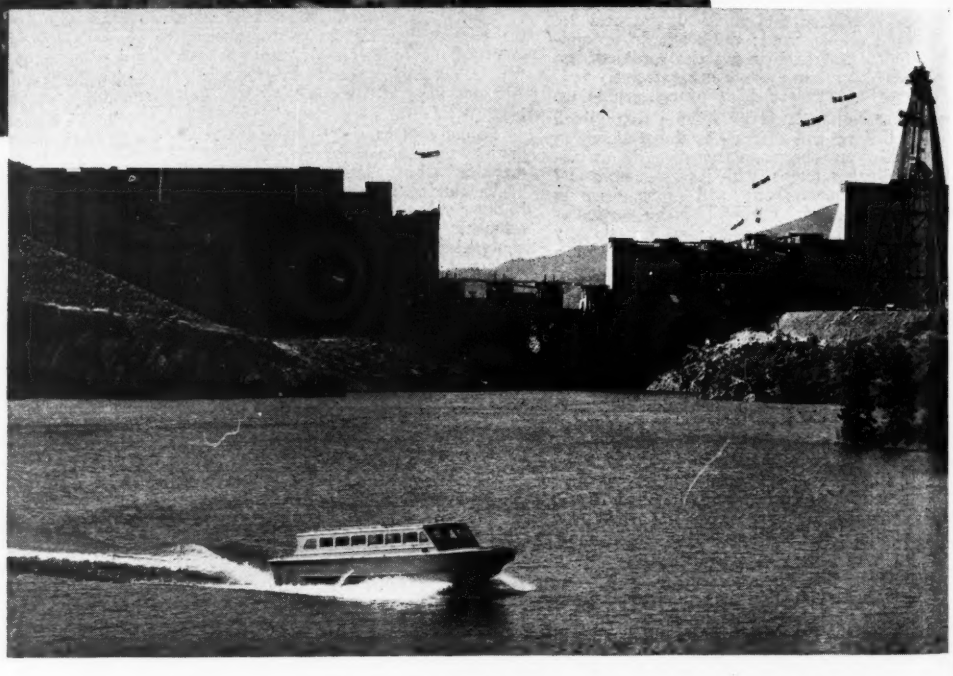
One thing that I think we are sure to run into is an exceedingly large college enrollment for a period of three years or so after the war. We will have an unusual demand for training, and that training probably will have to employ some rather unorthodox methods.

I think we are going to have to be more flexible in our standards after the war. I don't mean lowering standards, but I think perhaps more flexible in allowing certain substitutions in order to take care, with humaneness, of the situation in which a lot of these fine young men and women will find themselves.

The government is bound to do some sort of a tapering off job and not just cut off sharply at the end of the war; tapering off as to mobilization, tapering off in industrial operations, and tapering off generally to get back to the peacetime basis. In that sort of a program, a program could be set up which could include scholarships or such other type of aid as may be necessary to help this accumulated group of partially educated students, who have been drawn into war service, to return to educational institutions. It would be the finest investment I can think of for the future of the United States.

Karl T. Compton, president of Massachusetts Institute of Technology, gives here what seems to us a most accurate and penetrating analysis of what lies ahead in engineering education. This is to be expected in view of his present point of vantage and his background as a scientist. He was instructor in chemistry at Wooster in 1909-10, at Reed College 1913-16, was assistant professor of physics at Princeton 1915-19, professor 1919-30, research professor and chairman of the department 1929-30. Since 1930 he has been president of M.I.T. From 1917 to 1919 he was an aeronautical engineer in the U. S. Signal Corps and served as associate scientific attache to the American Embassy in Paris. He was consulting physicist for a number of years for General Electric Co. and the U. S. Department of Agriculture and has been a member of committees and boards of trustees of many industrial organizations, educational institutions and scientific bodies. He was awarded the Rumford Medal in 1931 for his contribution to the fields of spectroscopy and thermonic emission, is the author of scores of publication in those and in related fields such as x-rays, ionization of gases, photoelectricity and so on. These comments are from one of three papers on past, present and future of engineering education (the first two by Deans Hammond and Potter) presented at the 50th Anniversary Meeting SPEE in Chicago, June, 1943

Power



THE BUREAU OF RECLAMATION is adding a new lake—its 88th—to the map of the west. Water from the Sacramento River is rising steadily in a 35-mile long reservoir behind Shasta Dam of the Central Valley Project in California—water for irrigation, for power production for flood control and for navigation. The aggregate capacity of the Bureau of Reclamation's man-made lakes in 16 Western states is 64½ million acre-feet which constitutes 80 per cent of the water storage in the West. The Shasta reservoir ultimately will contain 4,500,000 acre-feet. The upper photograph shows the downstream face of Shasta Dam. This is the huge spillway, over which some day a waterfall three times as high as Niagara will plunge. More massive than Boulder and higher than Grand Coulee, the structure is rapidly nearing completion, 94 per cent of the concrete having been poured. The last yard is expected to flow into place in 1944. Two Shasta generators of more than 70,000 kw each are scheduled to go into production in March, 1944, to serve important northern California war plants. Although the power generated by the Shasta Dam generators is highly important the primary purpose of the dam is to control the waters of the Sacramento River and furnish water for irrigation to the immensely rich and fertile Central Valley.

For Future Generations

THE POWER INDUSTRY, along with electronics, plastics, 1600 dollar homes and family helicopters, is coming in for a great amount of imaginative doodling these days. People who know very little about any of these things are painting rosy pictures of their postwar development; nothing, in the post-war world, it appears, is going to be anything like what it is today. A short time ago, the Reader's Digest, which is read by millions, published a glamorous article on the gas turbine which left the impression that the gas turbine would just about take over the generation of power in the post-war era and that all other forms of prime movers could be relegated to the scrap heap. On the other hand all sorts of fantastic predictions are being made in regard to electronics; even the old dream of the wireless transmission of power is being revived. So, people wonder what the power plant of the past-war years is going to be like.

◆ **NO DIFFERENT**—Well, we can tell them, quite frankly, that the post-war power plant is not going to be any different from the well-designed plant of today. Despite recent use of the gas turbine in the oil industry, the motive power in the post-war plant is going to be steam and the prime movers in the large plants are going to be steam turbines. Pressures and temperatures are not going to differ materially from those in use today. Boilers, or rather steam generators, will develop along lines set by present practice and while we may look for increased development in the forced circulation type of boiler, in general the post-war boiler plant will follow present day design. The most efficient steam stations of today are operating at a heat rate of slightly over 10,000 Btu per kwhr which represents a thermal efficiency of a round 34 per cent.

◆ **GAS TURBINES**—These predictions for the steam cycle do not imply that the development of the gas turbine cycle, or the Diesel cycle, or the mercury-vapor cycle will not continue. It is quite probable that the gas turbine will come into greater practical use and in some fields such as the railway field it may, before long, compete favorably with other types of prime movers but not in the large stationary power field. At present, the main obstacle in the further development of the gas turbine is the temperature limitation of the materials used in their construction. With the development of alloys capable of withstanding higher temperatures, the thermal efficiency of the gas turbine can be expected to increase but it should be obvious to anyone knowing something about thermodynamics that progress in this direction at the same time paves the way for the use of higher temperatures with consequent higher efficiencies with the steam cycle. The same thermodynamic equations which govern the efficiency of the gas turbine cycle are also valid for the steam cycle. Just now, we can only speculate as to how far the gas turbine cycle can compete with the steam cycle.

As far as power plant development is concerned, there have been no startingly new developments either in the equipment used or in the heat cycles employed in recent years. The development has been gradual, along lines well established before the war began and since the war no unusual changes have been made.

Of course, in referring to present-day plants we mean the most modern plants of today, the plants operating at pressures above 1000 lb and at temperatures above 900 F. Compared to the total number of power plants, of say over 100 hp capacity, such plants are few and there is opportunity for great improvement in the thousands of old and largely obsolete plants that have been operating under reduced maintenance and high loads during the past four years. These old, worn-out plants offer a great market for the sale of new power plant equipment after the war, but whether this market actually materializes will depend upon general business conditions.

◆ **POST-WAR PROSPECTS**—If employment keeps up and if the manufacturing industries continue production, they will need power and it is reasonable to assume that money will be spent in rebuilding and rehabilitating the power plants serving these industries. On the other hand, if there should be a serious post-war depression, with widespread unemployment and low production, it is quite unlikely that any considerable amount of money will be spent in buying new power plant equipment. The prosperity of the power industry is dependent upon general industrial conditions.

The chances are that the post-war power plant will depend largely upon coal as fuel. Oil, quite possibly, will be far too valuable a commodity to consider as a mere fuel for general use under boilers.

One of the favorite present-day pictures of the post-war world is one in which the skies are filled with countless thousands of aircraft of all sizes and descriptions and in which the ground is alive with high-speed Diesel-powered streamliners, automobiles, trucks, busses, etc. It makes a rosy scene and one which certainly is not imaginative; indeed it is merely an amplified peace-time version of what exists today. The only trouble with it is that a shadow is beginning to steal over it, the shadow of our diminishing petroleum reserves.

◆ **RUNNING LOW**—As many articles on the subject have pointed out recently, we have arrived at the point in our use of petroleum where we not only consume immediately every barrel that comes out of the ground but a little more besides. In other words we are drawing upon our above-the-ground reserve stocks being able to replenish these reserves.

This is not merely a result of the war. While it is true that our armed forces are taking about 25 per cent, civilians are taking less. Actually the percentage rise in oil consumption from 1939 to 1943, including war needs, is less than the peace-time rise in the preceding four years, from 1935 to 1939. The grim fact is that we are not discovering new oil reserves at anywhere near the rate we should if our production of oil is to keep pace with our consumption demands.

During 1934 to 1938, new oil reserves were discovered at the rate of 2000 million barrels per year. After 1937 the rate of new discoveries decreased markedly, from somewhere over 900 million barrels of ultimately productible oil found in that year, to 400 million found in 1941 and 250 million in 1942. During the same period, the size of the new fields continued to decline. Most of the decline in the rate of discovery came before the war imposed difficulties on random exploratory drilling. While it is possible that some very large fields may be discovered, the uncertainty of such a happening increases as more and more territory is explored.

Contrasted with our declining oil reserves, our estimated coal reserves are said to be sufficient at the present rate of consumption to last some 3000 yr. There is still enough coal so that we do not have to worry about it.

◆ **WATER POWER**—Besides coal, we have water power, not enough to satisfy all our needs, yet a considerable amount and more and more use can be expected to be made of it. On the opposite page are two views of Shasta Dam in California, now nearing completion. This dam, together with Boulder Dam and the Columbia River projects, Bonneville, Grand Coulee, etc., will furnish much of the power needed in the Western States. As time goes on more and more of these water power resources will be developed.

The great water power developments, exemplified by Grand Coulee and Boulder Dams, are the only ones which give promise of a truly lasting source of power. Water power is the only large-scale source of power available to us that utilizes the energy of the sun more or less directly. All other energy, except a little produced by the wind and that produced by burning wood, is derived from the fossil stored sunshine of past ages. Once this energy is used up there will be no more.

◆ **URANIUM 235** — At the present time some work is being done to solve the riddle of the vast amount of energy locked up in the atom and thus make atomic power available to man. Only a few years ago the probability of the release of atomic power appeared fantastic but early in 1939 the fission of uranium 235, with the release of enormous energy, was demonstrated in a number of laboratories. The actual amounts of energy involved in these experiments was infinitesimally small but the results are encouraging and worth a great deal of further study and effort. If this riddle should be solved all our energy worries would be over but it is a wise adage that warns us not to count our chickens before they are hatched.—AWK.

South Meadow's New 40,000 Kw

Hartford Electric Light Co's. South Meadow Station begun in 1921 with 20,000 kw now has capacity of 170,000 kw. New 40,000 kw unit installed in 1942 operates at 850 psi. Generator, hydrogen cooled. Simple heat balance uses three stages of heating. New flood control system and new coal storage yard

TWENTY-TWO YEARS AGO, in our December 15, 1921, issue, we published an article describing in great detail the initial installation at the South Meadow Station of the Hartford Electric Light Co. This first installation consisted of a 20,000 kw turbine generating unit and four 1400 hp stoker fired boilers operating at about 250 psi. Until that time, Dutch Point Station had been Hartford's main generating station; its limiting capacity had been reached, however, and so this new station had been planned.

The new South Meadow Station was designed along the most modern lines. The Hartford Electric Light Co. had always been a pioneer in adopting advanced methods and apparatus. It had been the first public service company to install a steam turbine for generating power. Naturally, in planning the new South Meadow Station in 1921, it displayed the same forward-looking spirit.

During the years since 1921 the company has maintained this forward-looking spirit at all times. Under the able management of Samuel Ferguson, president of the company, and the equally able personal supervision of T. H. Soren, vice president in charge of engineering, it has taken advantage of every improvement and development the industry had to offer, and in many things it pioneered. As is well known, Hartford Electric was the first company to install a mercury boiler and turbine—first an experimental unit at Dutch Point and later, in 1928, a 10,000 kw commercial unit at South Meadow. This latter unit was, perhaps, the earliest topping installation in an American station.

After the construction of the first 20,000 kw unit in South Meadow Station in 1921, a second 20,000 kw unit was installed in 1923. At that time the plant contained four stoker-fired boilers operating at 250 psi, 650 F total steam temperature.

In 1928 these two units were topped by the 10,000 kw mercury turbine already mentioned. While the mercury installation has fully justified its use in terms of economy and reliability, the design of the boiler was not applicable to the larger capacities now required and so, when more generating capacity was required in 1929, a 40,000 kw, 375 psi, 750 F turbine generator was installed. At first this machine was operated from the original boilers at 250 lb pressure but in 1930 with the installation of a new 450 psi boiler, the operating pressure of the turbine was raised to 375 lb.

Station Capacity Now 170,000 kw

The steam generating mercury condenser had been designed to produce steam either at 256 lb or at 375 lb so the mercury plant can be used to top any of the first three steam turbine units.

With the installation of the third machine in 1929 the station had a total generating capacity of 90,000 kw; 80,000 kw in steam and 10,000 kw in mercury. In 1938, when more capacity became necessary, another 40,000 kw machine was added together with a 400,000 lb per hr, 950 psi boiler.

At that time studies were made of higher and lower steam pressures than the 850 lb 900 F finally adopted for the 1938 unit and an analysis was made also regarding the possibility of a steam topping installation for the 250 lb system. The results of these studies, however, were in favor of the

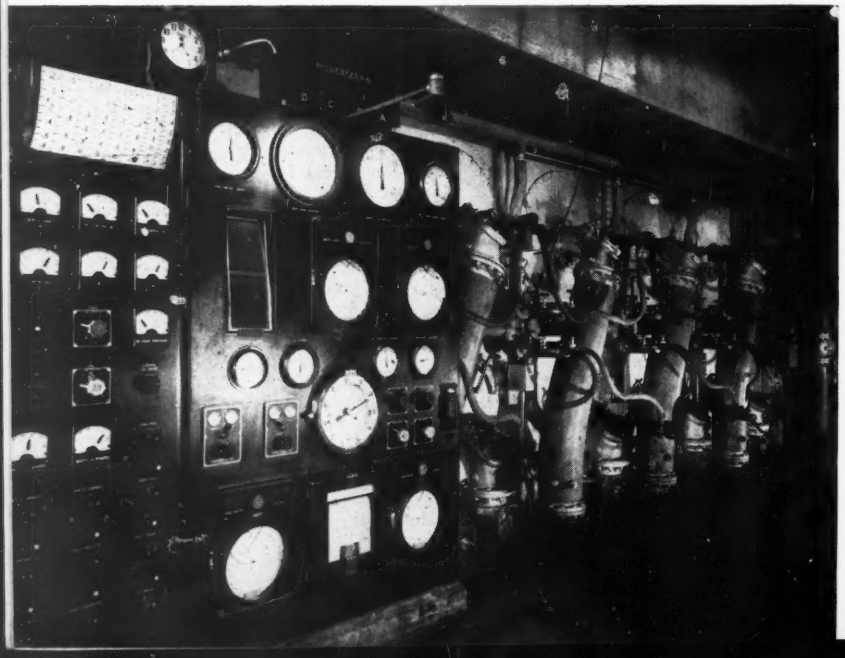


Fig. 1. The boiler control board for the new 425,000 lb per hr boiler and the combination pulverized coal and oil burners. There are eight burners arranged in two rows of four

Extension

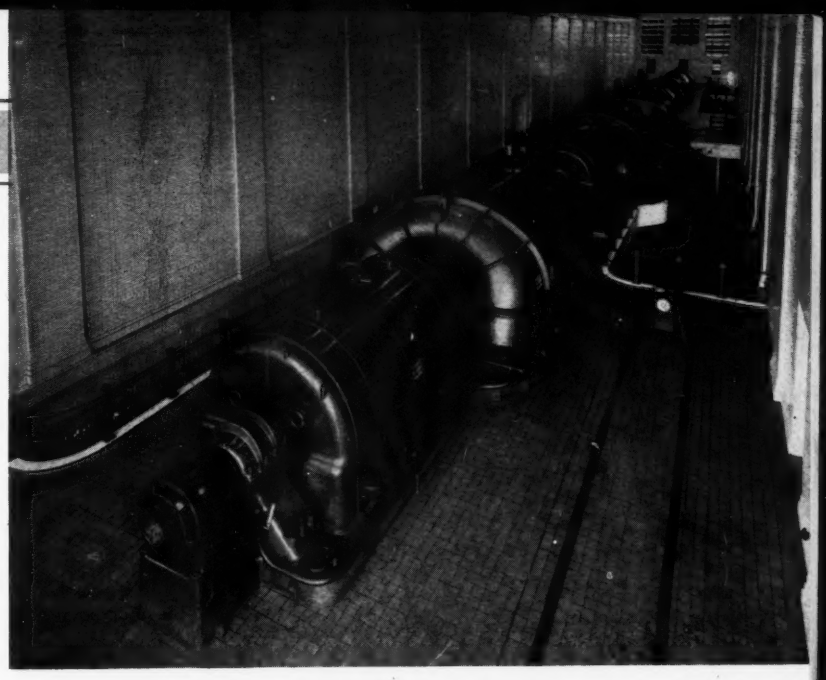


Fig. 2. A general view in the South Meadow turbine room showing the new generating unit in the foreground. This view shows 20 years of development in station design. The generator at the far end is the first 20,000 kw machine installed in 1921

straight 850 lb plant. This 1938 installation was fully described in an article by Wm. F. Ryan, mechanical engineer of Stone & Webster Engineering Corp. in February, 1939.[1]

During the past year, a fifth steam turbine generating unit has been placed in operation. The installation of this machine was begun in 1942. Hartford is the center of a tremendous industrial area and this new unit was given high priority because the power was needed for vital war production.

Hydrogen Cooling, New Feature

The 1942 extension is similar to the 1938 extension. It consists of a 45,000 kw, 3600 rpm turbine-generator, similar to the one installed in 1938 but the new machine differs in that the generator is hydrogen cooled whereas the 1938 generator is air cooled. Hydrogen cooling had been considered in 1937 when the 1938 machine was planned but at that time it was felt that hydrogen cooling had not reached a stage of development to warrant its use. It is of interest to know that the two 40,000 and the last 45,000 kw turbine units are all installed in spaces originally planned for 20,000 or 30,000 kw units.

There is no need here to describe in detail the features of all the equipment in the 1942 installation because in general it duplicates that of the 1938 extension and that was fully covered in the article by Mr. Ryan referred to above. A few details of the principal equipment will be given, however.

The boiler is a Babcock & Wilcox Co. sectional header, cross drum high head type boiler with completely water cooled walls, fired by eight, B & W circular combination burners designed to burn either pulverized coal or Bunker C fuel oil. Because of the critical fuel oil situation in New England at the present time, the entire station operates on coal. (Previous to November 1, 1943.)

Pulverized coal is supplied to the boiler by four Riley duplex Atrita unit pulverizers equipped with recirculators, coal feeders and magnetic separators. Each mill is designed for a maximum output capacity of 15,000 lb per hr.

As in the 1938 installation, the gas flow is vertically upward through the boiler, superheater and economizer and through twin regenerative type air preheaters to the induced draft fans which discharge upward to the superimposed steel, brick-lined stack. This direct flow, continuously upward, requires a minimum of duct work and the friction loss is unusually low. The air flow is equally direct. Each of the two forced draft fans discharge downwards through the air preheaters and down each side of the boiler setting to the burner windbox.

Supply and Preheating of Combustion Air

The new 45,000-kw turbo-generator unit was placed in operation in January, 1943, just about a year ago. As already pointed out, as a part of this project, there was installed a 450,000 lb per hr steam generating unit. The addition of this boiler raised the total combustion air requirements of the station to approximately 500,000 cfm. The boiler room at the South Meadow Station is relatively small and compact. Until the addition of the new boiler there was sufficient leakage to provide the air requirements without objectionable negative (sub-atmospheric) pressures or operating conditions within the plant, but this situation no longer exists with the large increase in air necessary for the new equipment.

During periods of low ambient temperatures, it is necessary to keep closed all doors and windows to prevent the freezing of water pipes, gage glasses, etc., and to provide "livable" operating conditions for the personnel. It soon became evident that special facilities would be required for admitting air to the building to augment the normal infiltration. In February, 1943, an ambient of minus 24 F was reached, at which time a negative pressure in excess of ¼ in. of water existed throughout the plant with some 20 per cent of the boiler capacity out of service. Such extreme draft conditions existed that the back draft through an idle boiler caused the freezing of the water in the economizer section. This high negative pressure made it impossible to obtain maximum rating from the station during extreme cold weather.

To remedy this condition, there has been recently completed a fan and air heating room which will deliver some 300,000 cfm of air, properly tempered, to the upper

[1] South Meadow's new 40,000 kw extension. By Wm. F. Ryan, page 96, Feb. 1939 issue.

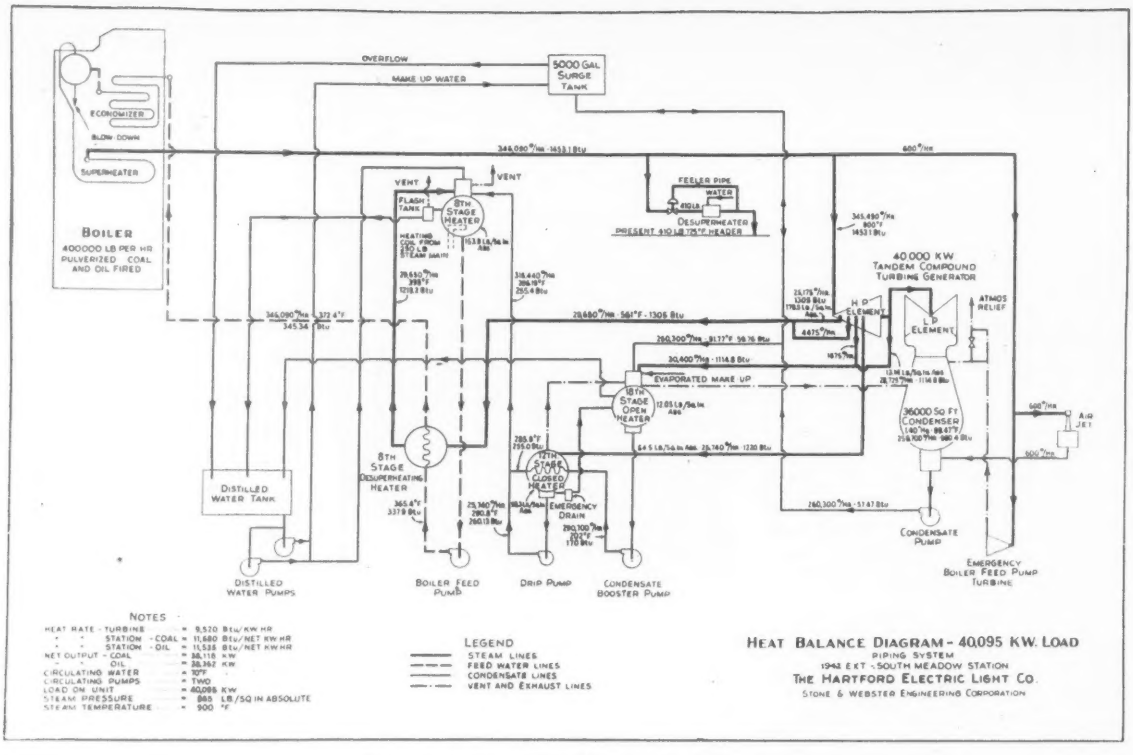


Fig. 3. The heat balance diagram for the 1942 unit

part of the boiler room to supply the intakes of the forced draft fans. Six propeller type fans, each rated 50,000 cfm at .25 in. wg and powered by a 10-hp, 220-v motor, deliver air into a plenum chamber, the front of which is formed by a bank of 14 Aerofin heating coils. The coil bank is divided into 2 sections, each of which is supplied with steam at some 60 psi from bleed points of 40,000-kw turbines, the condensate being returned to the evaporators of the respective supply units. The installation is designed so that the air pressure in the plenum chamber is just sufficient to overcome the static of the coil bank and based on a minus 10 F ambient will deliver the air into the boiler room at approximately 50 F. This equipment will be required to operate only when the outside temperature is below 32 F.

Two combination forced and induced draft fan units are provided. Each of these units consists of a forced draft fan and an induced draft fan mounted on one shaft and driven through an hydraulic coupling by a constant speed motor. The hydraulic couplings provide a smooth and accurate speed regulation from 20 to 98 per cent of the full motor speed which is 720 rpm. The draft system is designed for operation with one fan unit and one air preheater at light load. One of the forced and induced draft fan units is shown in Fig. 4. The speed of the fans is controlled automatically by the action of the combustion control system upon the hydraulic couplings.

The combustion control system is a Leeds & Northrup system utilizing pneumatic and electric operation for maintaining uniform steam pressure through the adjustment of combustion rate in response to load demand. This is a standard system with provision for either automatic or manual control. A view of the combustion control board is shown in Fig. 1. This view also shows the burner arrangement. The eight combination burners, it will be noted, are arranged in two horizontal rows of four.

The new turbine generator is a General Electric machine rated at 45,000 kw, 3600 rpm. The turbine has 21 stages with three openings at 8th, 12th and 18th stages for the extraction of steam. The last three stages are double-flow stages. These last three stages two for each stage. Duplicate coolers for lubricating oil are provided and a motor driven turning gear maintains the rotor at a speed of 2 rpm during standby and warming up periods. Like the machine installed in 1938, this unit is designed to produce 45,000 kw at the generator terminals at 90 per cent power factor. The normal steam pressure at the throttle is 850 lb gage and the steam temperature 900 F.

The generator is a 3-phase, 60-cycle, 11,400-v machine rated at 50,000 kva with field excitation at 250 v. The main exciter is a 160-kw, 1772-rpm, 250-v direct current generator driven therefore have six rows of blades, through reduction gears from the main generator shaft. This exciter supplies the field current for the main generator. A 4-kw, 250-v d-c pilot exciter also on the same shaft with the main exciter supplies the current for the field of the main exciter.

As already pointed out, the new generator is hydrogen cooled. This cooling system is designed for normal operation at 0.5 psi hydrogen pressure.

Condensing System

The turbine exhausts into a 3600 sq ft Westinghouse Electric & Mfg. Co. surface condenser. This condenser is of the two-pass, radial flow type with welded shell construction and non-divided cast

Fig. 4. This photograph shows one of the two combination forced and induced draft fans for the new boiler. Both the forced and induced draft fans are driven by a single constant speed induction motor through an hydraulic coupling

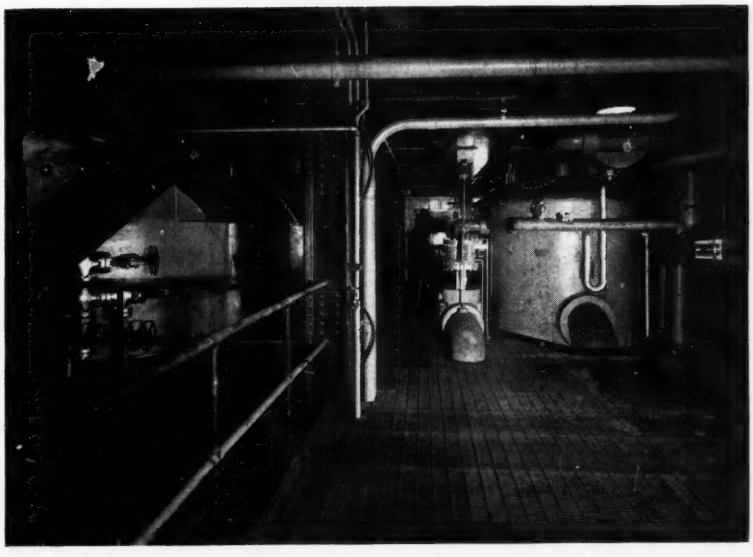


Fig. 5. This view shows the regenerative air pre-heaters at the left and the 8th stage feedwater heater at the right. The latter is an open heater and operates in series with the 8th stage desuperheating heater which is a closed heater

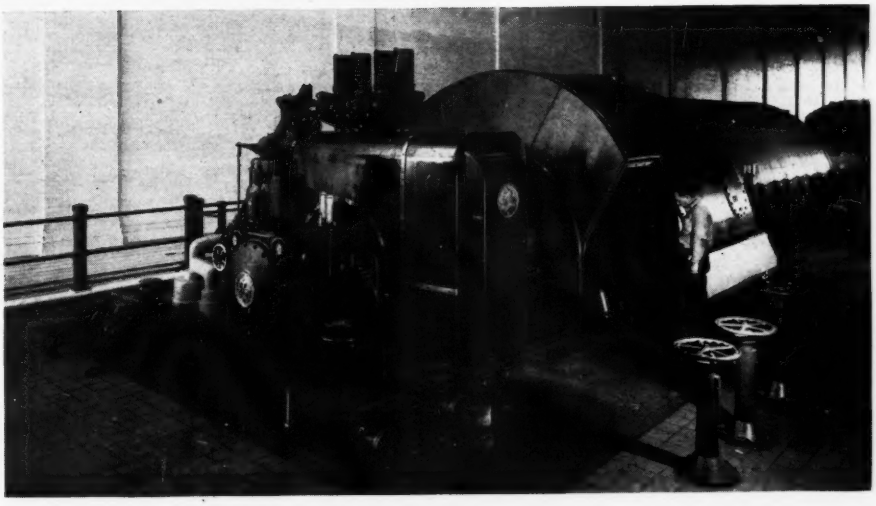


Fig. 6. The turbine end of the new generating unit. The machine is designed to deliver 50,000 kw continuously at unity power factor. The turbine has 21 stages and has three extraction stages for feedwater heating, at the 8th, 12th, and 18th stages. It is provided with duplicate coolers for lubricating oil. Normal steam pressure at the throttle is 850 psi with a total temperature of 900 F

PRINCIPAL EQUIPMENT, SOUTH MEADOW 1942 EXTENSION

General

Company: The Hartford Electric Light Co., T. H. Soren, vice president in charge of engineering.

Location: Hartford, Conn.

Service: Electric Light and Power.

Engineers and Constructors: Stone & Webster Engineering Corp.

Steam Generating Equipment and Auxiliaries

BOILER AND FURNACE: Babcock & Wilcox Co. —One sectional header, cross drum, high head type; boiler heating surface 4300 sq ft, drum diam 66 in. ID, water walls 4418 sq ft. Constructed for 975 psi WSP; capacity 425,000 lb per hr continuous evaporation. Boiler is also suitable for evaporating 450,000 lb of water per hr for four consecutive hr.

SUPERHEATER: Babcock & Wilcox Co. continuous tube convection type; 11,840 sq ft effective heating surface, designed for 915 F final steam temperature, and 875 psi gage pressure at maximum steam output of 450,000 lb per hr. Temperature automatically controlled by operating dampers.

ECONOMIZER: Babcock & Wilcox Co. continuous steel tube type; 18,350 sq ft effective heating surface, designed for a maximum WSP of 1075 psi gage and to raise feedwater temperature from 350 F to a final temperature equal to the temperature of saturated steam with a flow of 450,000 lb per hr.

SOOT BLOWER: Diamond Power Specialty Corp. — Boiler, superheater, and economizer equipped with complete soot blowing units.

AIR PREHEATERS: The Air Preheater Corp.— Two Ljungstrom regenerative type; 32,000 sq ft effective heating surface each, designed to raise air temperature from an inlet temperature of 80 F to 555 F final outlet temperature when boiler is operating at full output and burning pulverized coal.

PULVERIZERS: Riley Stoker Corp. — Four Riley duplex Atrita unit pulverizers with recirculators, coal feeders and magnetic separators. Each mill designed for a maximum output capacity of 15,000 lb per hr when using low volatile coal, based on coal to pass a 1¼-in. screen, with preheated air at 150 F. Pulverizers driven by General Electric, 125 hp, 1150 rpm induction motors.

FUEL BURNERS: Eight Babcock & Wilcox Co. circular combination burners, designed to burn either pulverized coal or Bunker C fuel oil.

FORCED AND INDUCED DRAFT FAN EQUIPMENT: American Blower Corp.—Two duplex Sirocco forced and induced draft fan units driven through size 42 American Blower Corp. hydraulic couplings by General Electric Co. 600 hp, 720 rpm induction motors. Forced draft fan, single width, single inlet, with dampers designed to discharge 81,000 cfm air at 11.25 in. water pressure. Induced draft fan, ⅔ double width, double inlet, with inlet boxes and dampers designed to discharge 141,000 cfm flue gas at 400 F at 10.5 in. negative water pressure at fan inlet.

COMBUSTION CONTROL: Leeds & Northrup Co.—Pneumatic and electric operation for maintaining uniform steam pressure through adjustment of combustion rate in response to load demand, proportioning supplies of fuel and air to maintain uniform combustion efficiency.

STEEL STACK: Connery Construction Co.— Self-supporting steel stack, 12'0" diameter inside lining, 60'0" high, with base 126'0" above yard grade.

ASH HOPPER AND ASH SLUICING: The Allen-Sherman-Hoff Co.—Cast iron ash hopper complete with lining, doors, quenchers, sluice and transport nozzles, grids, curb angles, cover plates, wear plates, and sluice liners.

Feedwater System

BOILER FEED PUMPS: Ingersoll-Rand Co.— Two No. 5 HST seven-stage, 1800 rpm, single suction, centrifugal pumps, one direct connected to General Electric 1000 hp induction motor, and one direct connected to a Terry steam turbine operating at a throttle pressure of 850 lb gage and temperature of 900 F, exhausting at atmospheric pressure. Total dynamic head 2610 ft when boiler is operating at full output.

CONDENSATE BOOSTER PUMPS: Ingersoll-Rand Co.—Two four-stage, 1800 rpm, single suction, centrifugal pumps, direct connected to 250 hp wound rotor, variable speed motors. Total dynamic head 710 ft at maximum load.

FEEDWATER REGULATORS AND EXCESS PRESSURE CONTROL VALVES: The Swartwout Co.— Constant differential pressure, thermal-hydraulic generator type regulators.

EXTRACTION HEATERS: Foster-Wheeler Corp. —One vertical 8th stage desuperheating extraction heater, one vertical 12th stage closed extraction heater, one 8th stage direct contact type open heater with 5200 gal storage tank, and one 18th stage direct contact type open heater with 2400 gal storage tank.

CHEMICAL FEED EQUIPMENT: Hills-McCanna Co.—One single unit, two feed, proportioning pump driven by General Electric ¼ hp, 1725 rpm, drip-proof motor through enclosed reduction gearing.

Tippett and Wood—One 100 gal phosphate feed tank, and one sulphite mixing and feed tank.

Turbine Generator and Auxiliaries

TURBINE GENERATOR: General Electric Co.— One 45,000 kw, 3600 rpm turbine for condensing operation, having an overload capacity sufficient to deliver 50,000 kw continuously at unity power factor. Turbine 21 stages with three openings at 8th, 12th and 18th stages for extraction of steam. Last 3 stages double flow. Duplicate coolers for lubricating oil; motor driven turning gear. Normal steam pressure at throttle 850 psi gage and 900 F total temperature. One 45,000 kw, 90 per cent power factor, 50,000 kva generator, direct connected to turbine. Generator 3-phase, 60 cycle, 11,400 v, 3600 rpm, field excitation at 250 v. Generator hydrogen cooled designed for normal operation at 0.5 psi hydrogen pressure.

EXCITERS: General Electric Co.—One 160 kw, 1772 rpm, 250 v, direct current Main Exciter driven through reduction gear from generator shaft to supply necessary exciting current for field of main generator. One 4 kw, 250 v DC Pilot Exciter on same shaft with Main Exciter, to supply necessary exciting current for field of main exciter.

Surface Condenser System

SURFACE CONDENSER: Westinghouse Electric & Mfg. Co.—One 36,000 sq ft cooling surface, two-pass radial flow type, welded shell construction with non-divided cast iron water boxes. Two 18,000 gpm each, vertical propeller type circulating water pumps direct connected to 200 hp, 870 rpm, Westinghouse motors. Two 700 gpm each, horizontal 2-stage condensate pumps direct connected to 60 hp, 1160 rpm Westinghouse motors. Two 2-stage steam jet air ejectors each mounted on surface type inter and after condenser.

CONDENSER TUBES: Bridgeport Brass Co.— 36,000 sq ft or approximately 161,141 lineal ft consisting of 6930 tubes ⅞ in. OD, No. 18 BWG Admiralty mixture 23'-3⅜" long.

CIRCULATING WATER VALVES: The Chapman Valve Mfg. Co.—Two 30 in. OS&Y gate valves operated by General Electric motors. One 42 in. OS&Y gate valve, hand operated from floor stand.

CIRCULATING WATER LINES: Walsh Holyoke Steam Boiler Works, Inc.—30 in., 42 in. and 48 in. suction and discharge piping, welded steel plate, enameled by Wailes Dove-Hermiston hot process. Underground sections wrapped with two layers of 15 lb tar-saturated felt.

INTAKE WATER SCREENS: Link-Belt Co.— Two model D vertical traveling water intake screens, 6'0" wide, 59'2" deep, driven through speed reducers by General Electric 5 hp, 1750 rpm, splash-proof motors. Screens complete with refuse trough and spray piping.

SLUICE GATES AT INTAKE WELL: The Chapman Valve Mfg. Co.—Two 48"x72" cast iron gates with hand-operated floor stands.

TRASH RACKS: The Whitlock Manufacturing Co.—Two sets of racks.

CIRCULATING WATER CHLORINATING EQUIPMENT: Wallace & Tiernan Products, Inc.—Chlorinators, accessories, and piping added to present system to inject chlorine gas into condenser water pipes of 1942 turbines.

Electrical Equipment

AUTO-TRANSFORMERS: General Electric Co.— Three 50,000 kva, three-phase auto-transformers, indoor type, 11/22 kv, 60 cycle, Pyranol immersed, forced Pyranol cooled. One used to step-up output of 1942 generator to 23 kv, other two used to connect present 11 kv duplicate main buses to 1942 metal-clad 22 kv double bus switchgear.

SWITCHGEAR: General Electric Co.—Metal-clad 22 kv switchgear, double bus on separate floors of electrical bay for the control of output from 1942 generator, and six feeder circuits. Oil circuit breakers type FH126, 1200 and 2000 amp, interrupting capacity 1,500,000 kva. Metal enclosed bus runs from 11 kv buses at auto-transformers to 22 kv switchgear. All indoor 22 kv equipment completely metal enclosed, including buses, oil circuit breakers, disconnects, reactors, current and potential transformers. Kirk interlocks (R&IE Company) on all disconnects and access doors assuring proper sequence of operations for switching and inspection. Station service 2300 v metal-clad type MI-6 and MI-9 switchgear, and truck-type panels. Main switchboard panels consisting of benchboard type control panels, and vertical instrument, relay and meter panels.

TRANSFORMERS: General Electric Co.—One 6000 kva, three-phase, outdoor type, oil insulated. self-cooled, 60 cycle station auxiliary transformer, 11,000/2300 v.

REACTORS: General Electric Co.—Three single-phase metal-clad reactors, 167 kva, 630 v, 265 amp on each outgoing feeder designed to give 5 per cent reactive drop in a 10,000 kva, 22 kv circuit.

Instruments

BOILER METER, WATER LEVEL RECORDER AND DRAFT GAGES: Bailey Meter Co.

STEAM AND WATER FLOW METERS: Bailey Meter Co.

RECORDING THERMOMETERS: Leeds & Northrup Co.; The Bristol Co.

INDICATING THERMOMETERS: The Foxboro Co.; Taylor Instrument Cos.

TEMPERATURE RECORDER CONTROLLERS: C. J. Tagliabue Mfg. Co.

INDICATING PRESSURE GAGES: Crosby Steam Gage & Valve Co.; Consolidated Ashcroft Hancock Co., Inc.; The Ashton Valve Co.

BAROMETER AND VACUUM RECORDER: Uehling Instrument Co.

CONDENSER CONDUCTIVITY RECORDER: Leeds & Northrup Co.

GAGE BOARDS: G and N Engineering Co.

Miscellaneous Equipment

COAL HANDLING: Stephens-Adamson Mfg. Co.

CAISSONS: Western Foundation Co.

PIPING: Grinnell Company, Inc.

PIPE COVERING: Johns-Manville Sales Corp.

VALVES:

BOILER SAFETY: Consolidated Ashcroft Hancock Co., Inc.

BOILER NON-RETURN: Schutte & Koerting Co.

BOILER FEED STOP AND CHECK: The Edward Valve & Mfg. Co.

BOILER BLOW-OFF: Yarnall-Waring Co.

HIGH PRESSURE GATE, STEAM AND WATER: The Chapman Valve & Mfg. Co.

HIGH PRESSURE, GLOBE AND CHECK: The Lunkenheimer Co.; Manning, Maxwell & Moore, Inc.

LOW PRESSURE, GATE AND GLOBE: Reading-Pratt & Cady Co., Inc.; Walworth Co.

ATMOSPHERIC RELIEF: Atwood & Morrill Co.

CONTINUOUS BLOWDOWN: Manning, Maxwell & Moore, Inc.

RELIEF: Crosby Steam Gage & Valve Co.

EVAPORATOR: The Griscom-Russell Co.

HEAT EXCHANGER: The Whitlock Mfg. Co.

BLOWDOWN SAMPLE COOLER: Bailey Meter Co.

SUMP PUMPS: Ingersoll-Rand Co.; Worthington Pump and Machinery Corp.

FUEL OIL PUMPS: Quimby Pump Co.

LUBRICATING OIL PURIFICATION EQUIPMENT: S. F. Bowser & Co., Inc.

COOLING WATER PUMPS, HEATER DRIP PUMP, LOW SERVICE WATER PUMP: Worthington Pump and Machinery Corp.

ASH SLUICING PUMPS: Goulds Pumps, Inc.

MISCELLANEOUS TANKS AND PLATE WORK: The Whitlock Mfg. Co.

CONTROLS AT EXTRACTION HEATERS: The Swartwout Co.

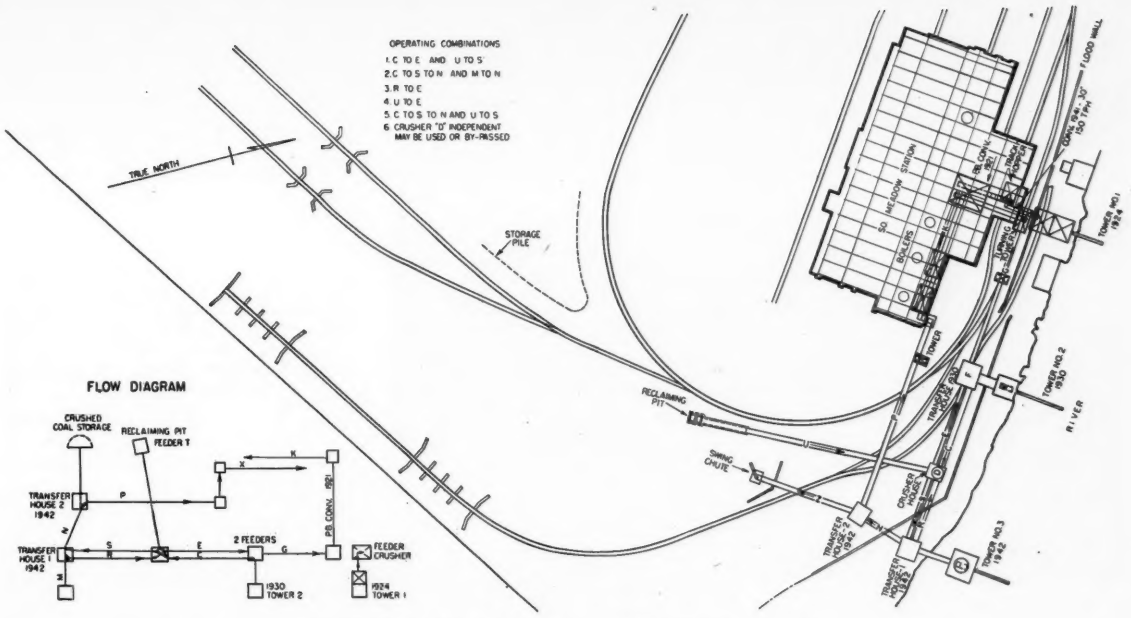


Fig. 7. Plan of the new coal storage and handling arrangement

iron water boxes. The steel-plate shell of the condenser is welded to the exhaust nozzle of the turbine.

Circulating water is taken directly from the Connecticut River but this is chlorinated at the intakes to prevent the growth of algae in the system. As in the case of the 1938 extension, circulating water is pumped through the condenser by two 24,000 gpm each vertical propeller type circulating water pumps, driven directly by 200 hp 870 rpm motors. These pumps are located in the screen house on the river bank.

The circulating water lines are of welded steel plate, enameled by a special hot process inside and out and the underground sections are wrapped with tar saturated felt.

The heat balance diagram for the 1942 extension is shown in Fig. 3 and this explains the general arrangement of the equipment as well. This heat diagram is almost exactly the same as for the 1938 unit and it involves the same fundamental principles of design. The heat balance, it will be noted, is comparatively simple, only three extraction stages being employed. Many plants operating at comparable pressures use four or even five stages of feedwater heating. In this case, however, the heat balance was designed primarily for reliability, operating simplicity and low generating costs including capital charges as well as production expense. While additional feed heating stages would have increased the thermal efficiency, and while a reasonably high efficiency is essential to low production expense with New England fuel prices, each stage of extraction adds to the capital cost and operating complexity. To conform with the principles of design referred to above, it was decided to limit the number of extractions to three, but to make highly effective use of each stage in the feedwater heating cycle. The fact that this system is the same as that already in use in the 1938 installation has another advantage in that the operators were already familiar with it.

The diagram in Fig. 3 is almost self explanatory. Condensate is delivered by the condensate pump to an open heater receiving steam from the 18th stage of the turbine. It is then delivered by a booster pump through a closed heater at the 12th stage to a second open heater at the 8th stage. The main feedwater pump takes suction from this 8th stage heater and delivers the water to the economizer through the 8th stage desuperheating heater which is a closed heater.

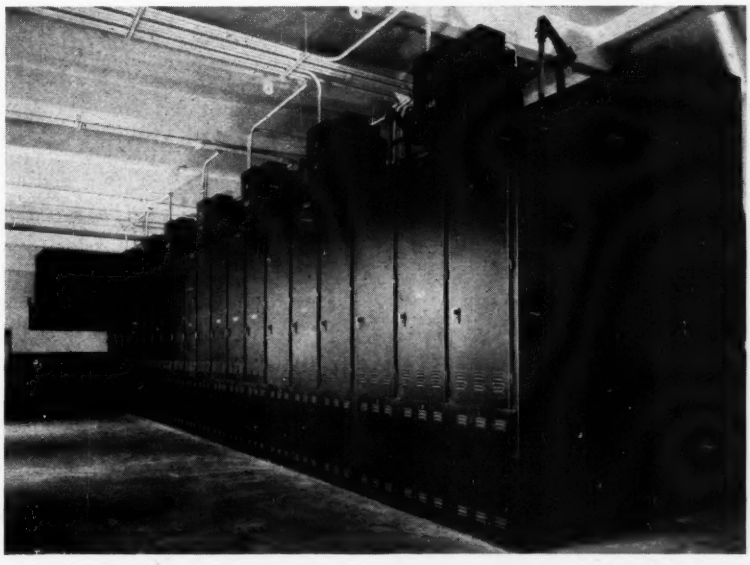


Fig. 8. All high voltage electrical equipment is metal clad. This shows the 22-kv metal-clad bus

Evaporator equipment pro-

Fig. 9. (Left) A general view of the new coal handling arrangement at South Meadow from the top of the turbine room

Fig. 10. (Below) This is a view taken from the boiler house roof of the coal storage yard. All coal in storage is crushed before it is stored. This effectively prevents spontaneous combustion because of the more compact packing

vides the makeup water for the new unit. Surge tanks beneath the 18th stage and the 8th stage heater provide a liberal storage volume of hot condensate in the system. The 8th stage heater storage tank has a capacity of 5200 gal and the 18th stage heater 2400 gal.

Two 7-stage, 1800 rpm Ingersoll-Rand centrifugal pumps are installed, one driven by a 1000 hp induction motor and the other direct connected to a Terry steam turbine. The steam driven feed pump which is started automatically by loss of differential pressure across the feedwater controls has a suction line connected to a 40,000 gal underground cold condensate tank but this connection is for use only in extreme emergency. The distilled water pumps, started automatically by low level in either of the hot surge tanks, deliver water from the distilled water tanks to the 8th stage heaters or the surge tank which feeds the 18th stage heater and insures a supply of hot deaerated water to the feed pumps at all times.

As pointed out by Mr. Ryan in his article on the 1938 extension, open heaters, by heating the condensate to the full saturation temperature of the steam, extract more steam from the turbine than would be possible with closed heaters, where some terminal difference between the temperature of the steam and water is unavoidable. The open heater at the 18th stage extracts approximately 4 per cent more steam than would be possible with a closed heater of reasonable cost and dimensions. This is particularly desirable at the lowest pressure extraction, where the steam has converted more of its energy into power than at the higher stages. The higher quantity of steam extracted by open heaters has a compound effect; it reduces the flow to the condenser, where the latent heat is lost to the circulating water, and it reduces the flow and velocity through the lowest pressure wheels of the turbine, resulting in a higher efficiency in the final stages.

These same considerations apply, though with less force, to the 12th stage heater. In this case, however, a closed heater is used to avoid the cost and complication of a second booster pump. The efficiency sacrificed is relatively small. As will be noted, a drip pump is provided to avoid the degradation of energy which would result from following the common practice of cascading drips to the lowest pressure heater.

The combination of an open and closed heater at the 8th stage gives the maximum possible steam extraction at that point, where bled steam is highly superheated, and results in the highest possible feedwater temperature entering the boiler. There is another advantage in using the open heater at the 8th stage; this is its effect upon the feed pump performance. The pressure in this heater increases with the load on the main turbine, giving a higher suction pressure with increasing rates of output. Because of the increased friction in piping, controls and economizer, the feed pump discharge pressure also rises with increasing load, but the suction pressure rises more rapidly than the discharge pressure, and the total dynamic head on the pump decreases as the delivery goes up. The result is that the system characteristic approximates the constant speed characteristic of the pump, and although the pumps are driven by constant speed induction motors, very little power is wasted by throttling at the boiler feedwater level controls, even at light loads. The advantage of the constant speed induction motor for this large and important drive is obvious.

(*Continued on page* 126)

What Is This Asymmetrical Current And Why Do We Bother With It?

By E. H. BECKERT
Switchgear Division
General Electric Company

DURING the past few years we have been reading a great deal about the importance of properly selecting overcurrent devices for the protection of a-c low voltage feeders, branch circuits and various types of electrical apparatus and equipment (600 v and below). Especial emphasis has been placed upon the necessity of choosing such devices with sufficient interrupting ability to take care of the worst short circuit conditions. We have been impressed with the necessity of determining the maximum fault current by actual calculations. This has come about because tests and experience have disproved what was once a rather widespread belief that short circuits on such low voltage systems could not reach magnitudes greater than 20,000 to 25,000 amp. We know now that short circuits over 100,000 amp on low voltage circuits are possible.

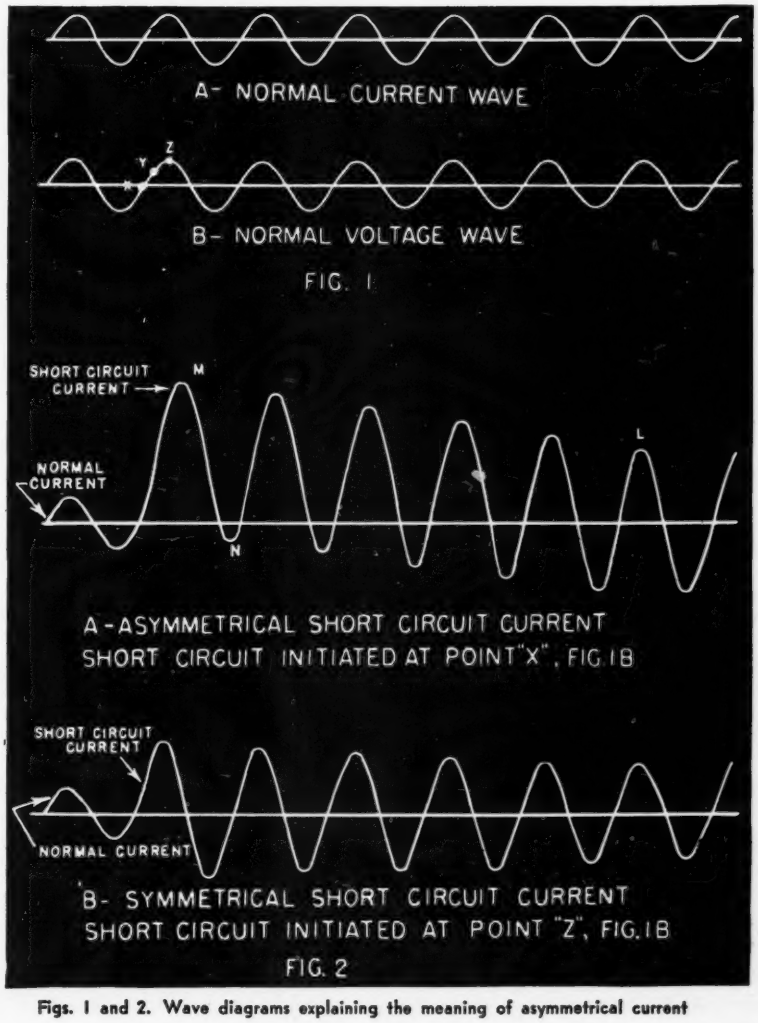
Before we can select a device capable of interrupting the short circuit current we must know how to calculate the magnitude of this current and here is where the rub came. There was no well known reliable method. But our engineers have progressed and they have given us a method. However, in explaining the process they talk about asymmetrical currents, d-c component, and offset current among other more understandable things, and these terms puzzle us.

Shunning high-brow explanations, just what are these asymmetrical currents and why must we bother with them? From the purely definitive standpoint Mr. Webster says "asymmetrical" means "not symmetrical". That's easy. And from the electrical viewpoint also the answer is not too difficult to understand in so far as we have to understand it to apply the rules for figuring short circuit current.

We all know from its very name that an alternating current or voltage is not of continuous, steady value but has its ups and downs or, a bit more technically, has two loops per cycle, one above and one below the zero line (Fig. 1A), passing through zero 120 times per second on our common 60-cycle circuits. Under normal conditions the loops are of equal magnitude above and below the zero line as shown in Fig. 1A. The same is true of the voltage, Fig. 1B.

Now when a short circuit occurs, considering one phase only, it may be initiated at the point where voltage wave is passing through zero (X on Fig. 1B), at a point half way up the voltage wave (Y on Fig. 1B), at the maximum point (Z on Fig. 1B), or at any other point of the voltage wave. The point at which the short catches the normal voltage loop determines whether the first and succeeding few loops of current will remain symmetrical, although increased in magnitude, or whether they will be not symmetrical (asymmetrical) and how badly asymmetrical. If

(*Continued on page* 110)



Figs. 1 and 2. Wave diagrams explaining the meaning of asymmetrical current

A. G. Christie *Professor of Mechanical Engineering*
The Johns Hopkins University, Baltimore, Md.

discusses

The Spinning Turbine on Power Systems

Early experiences . . . modern spinning reserve units . . . comments on 65,000-kw Harbor Steam Plant unit . . . effect of load changes . . . rapid temperature changes in spinning units . . . turbine casing and rotor construction . . . provisions for rapid warming-up . . . response of boiler to quick load change . . . fan, feed pump, circulating pump response . . . method of furnishing auxiliary power . . . fuel supply response . . . accumulator effect in boiler . . . design of spinning turbine plant requires much skill and ingenuity

WHEN AND UNDER WHAT circumstances is a spinning turbine employed? What has been past experience with their use? Are modern steam conditions conducive to their extended use? What special provisions must be made to enable modern units to serve as spinning reserves?

Early Experiences

One of the writer's earliest experiences with a spinning turbine was in 1908, when serving as mechanical engineer in a Canadian cement plant. Three Allis-Chalmers-Parsons turbines of maximum continuous capacity of 1250 kw had been installed in the power plant. At that time there was no outside power connection at this station. The power factor of the plant was very poor owing to the wide use of large induction motors, almost all underloaded. No attempt was made to correct power factor and it was necessary to keep all three turbines on the line at rated kilovolt-amperes when the mill was in full operation. No watt meters were installed in this particular plant.

One morning it was found that the overspeed valve of one turbine had been accidentally tripped during the night and the turbine was being motored from the generator end. Evidently this had occurred early the evening before, because the turbine casing was cold right up to the throttle valve. The operator had adjusted the field to give equal kilovolt amperes on all units but had not noticed the closure of the overspeed valve. The turbine ran smoothly at synchronous speed under full vacuum.

Motorized Turbines—Spinning Reserve

While each generator had the same ampere load on the switchboard, it was evident that much of the wattless load was being carried on the motorized generator which was now operating as a synchronous condenser. The other two generators carried the mill load plus the small power required to operate the third generator as a motor. These two units were then operating near their most economical load point at a steam rate of about 19.7 lb per kwhr. where previously they had carried a lower load at poorer economy of about 21.5 lb per kwhr. The net result was a 9 per cent decrease in steam demand and a corresponding coal saving.

The motorized turbine was allowed to operate for a month under full vacuum with no harmful results, and with the governor auxiliary spring unscrewed slightly so that it did not open the steam valves. At the end of the month, the governor auxiliary spring was tightened, and the spinning unit was permitted to gradually warm up, take on load, and function as usual. The overspeed valve of one of the other units was tripped and it was allowed to motor for a month as a synchronous condenser. These methods became standard practice in the plant and are believed to be one of the first uses of a direct-connected turbine-generator as a synchronous condenser. At the same time, this spinning unit could pick up load when frequency

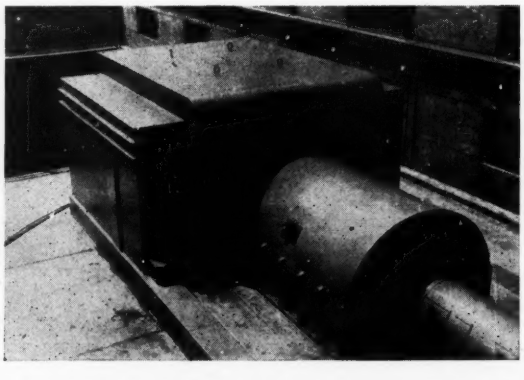


Fig. 1. Outdoor 20,000-kw turbine-generator unit installed primarily to supply increasing power demand but at the same time connected to a large transmission system, served mostly by hydroelectric power, in such a way as to furnish spinning reserve reliably at very low load conditions

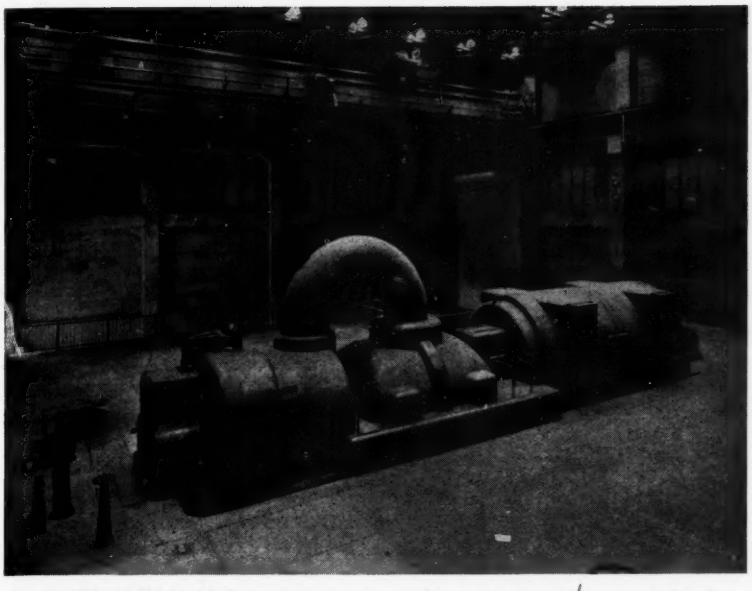


Fig. 2. This 65,000-kw Harbor spinning reserve turbine generator unit, connected to large transmission system, served mostly by hydroelectric power, is built to respond to very rapid load increase from 5000 to 65,000 kw, the boiler responding in 20 to 25 sec

dropped a small amount. While such an event did not occur during early stages of operation, this unit, to all intents and purposes, was a "spinning reserve."

The average steam conditions at this plant were 150 psi gage and 466 F at the throttle and 2 in. abs at the exhaust. The altitude of the plant was about 3500 ft above sea level. No harm appears to have been done to these spinning turbines, for they operated in a satisfactory manner for many years. This may have been due in part to the low steam temperatures in use and to the liberal clearances provided in the early turbines.

While it was possible to operate these older turbines under motoring conditions and with full vacuum, it should be pointed out that blade speeds were low in this design. Some modern units with high blade speeds generally require a small flow of steam to serve as a cooling medium on the revolving blades.

Later Operating Methods

When steam turbines were more widely used in power stations in later years, it was quite common practice to have a sufficient number of units on the line so that the load could be carried without system disturbance if one unit should fail for any reason. In some cases, the load was equally distributed between the units, which then operated sufficiently below full load rating to enable the remaining units to take on between them the load dropped by the unit experiencing the outage and still not to exceed their rated capacities. As far as these units were concerned, these load additions were no greater than normal load swings.

In other cases, incremental studies of loading indicated that it was economical to operate one of the oldest units at light load as a spinning reserve, to take on at a moment's notice any load dropped by another unit. The liberal clearances on the older unit and the comparatively low steam temperatures in many of the older stations made this load shift possible with no cause to worry over temperature changes in the turbine casing. In both these cases, the transfer of load from the unit that drops out of service to the remaining units or to the spinning reserve, results in no great change in boiler load nor are any special demands made on auxiliary services.

A Recent Spinning Turbine Installation

When steam stations are provided as stand-by reserves to distant hydro-electric plants, it is common practice to have at least one spinning reserve steam unit which floats on the line at light load. This unit would pick up load in case of an outage of transmission line or hydro plant. Certain war plants with processes that must be kept in continuous operation are said to employ spinning reserves as stand-by units to public utility service.

The Harbor Steam Plant of the City of Los Angeles, recently described in this magazine,* is an example of a plant of the general type noted above. It contains a 65,000-kw, 3600-rpm turbine built to operate normally at 850 psi gage, 900 F and 1.25 in. abs exhaust pressure. This unit will be in parallel with the Boulder Dam Hydroelectric Plant 265 miles distant and at times will serve as a spinning reserve, delivering 5,000 kw to the system but capable of picking up load to 75,000 kw if a failure should occur in the transmission system.

An outage occuring under these conditions increases the instantaneous steam demanded on the boiler from a rate of 60,000 lb per hr to as high as 675,000 lb per hr or an 11 to 1 ratio. The authors of the paper point out that this demand will be met in a novel fashion. Usually the pressure on a steam generator is maintained constant at the outlet of the superheater. At Los Angeles, the boiler drum pressure is kept constant. Since the drop through the superheater varies with load, the pressure at the turbine throttle increases as load decreases and vice versa. The boiler is provided with a large water volume, 3500 cu ft, which serves as a steam accumulator to provide steam for full load operation during 20 to 25 sec when an outage occurs and when the oil burners, fans, etc., are being brought up to the new load conditions. The paper previously referred to discusses these operations in detail.

Another factor in the Los Angeles plant should be noted. At 5,000 kw load (as spinning reserve) the steam temperature at the throttle will be about 700 F. When a sudden outage occurs this temperature will drop somewhat, momentarily, but as burners are cut in, it will rise and within a few minutes will reach the rated and controlled value of 900 F. The turbine builders believe that this change in temperature can be met without difficulty.

Effect of Load Changes on Turbines

Several problems are involved in the design of large steam turbines to operate under pressure and temperature conditions now in vogue. In the first place casings must be heavier to withstand the increased pressures. The desire for higher efficiency has led to refinements in clearances and packing

*Harbor Steam Plant Goes on the Line, by Charles P. Garman and William C. Rowse; page 64, Power Plant Engineering, June, 1943.

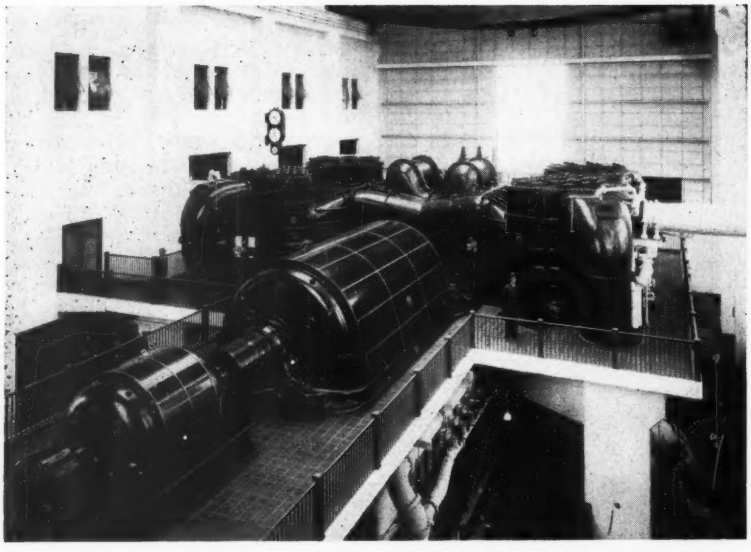


Fig. 3. View of a 94,000-kw tandem-compound turbine generator unit connected to a large transmission system. During much of the time when system is served primarily by hydro-electric stations, the above unit is operated at minimum load and as a spinning reserve connected to the system

details and to the employment of heavy rotor forgings and highly-stressed low-pressure blading. The response of these parts to sudden temperature variations due to load changes has been a matter of concern to some engineers. It is said that one manufacturer has endeavored to limit the rate of load change on certain of his turbines on account of the effects of the resultant temperature changes.

It is questionable whether load changes can be controlled as closely as this manufacturer desires, for the central station has no control of the rate of load addition out on the system. The station units must be ready to furnish all reasonable load demands. It is certain that all turbines that may operate as spinning reserves must be so constructed that they can successfully meet all load and temperature changes to which they may be subjected.

Design Details for Rapid Temperature Changes

Several considerations are involved in the design of such turbines. Since temperature differences between parts of the turbine give rise to the problems involved, these must govern the design. An extended discussion of these considerations is presented in "The Quick Putting-into-Service of Steam Turbines at High Steam Temperature" which appeared in the Brown Boveri Review, August, 1942.

The methods suggested in this article are those which have been followed by designers in this country, such as separate nozzle castings in the first stage welded in a special manner to the casing, the use of a Curtis stage at inlet to reduce pressure and temperature in the casing, casings of barrel form and uniform thickness with no sudden changes in diameter and with few or no ribs, and flanges as narrow as possible. All these are conducive to rapid and uniform heat distribution.

Increased bolt length is recommended, using bushes to obtain this increased length. Bolts screwed into one flange warm up more quickly than through bolts and are therefore less subject to stretching due to non-uniform heating.

To avoid trouble with rotors, the Brown Boveri article recommends some forms of welding not in common use here. For instance, loose discs can be avoided by pressing these on the shaft and welding each to a lip cut in the shaft, in place of using a key or other method of fastening. Spindles for reaction turbines can be built of discs with no hole at the center but with welds between the discs located near the circumference. The end discs are forged with stub shaft ends. This results in a rigid construction with low stresses in the discs.

Rapid Warming Up of Flanges and Casings

Several suggestions are offered in the article to provide more rapid warming up. The outside of the flanges may be heated by providing channels for the passage of live steam outside of the flanges, by welding split tubing to the flanges. Casings may be provided with electrical heaters under the heat insulation covering that can be turned on when temperature changes are to take place.

Summarizing these considerations, the use of high initial steam temperatures makes the response of a spinning turbine to rapid changes of load a matter of some concern. A more complete record of experiences in the operation of such turbines is desirable and would permit a better estimate to be made of the optimum operating conditions for such units.

Spinning Turbine Auxiliary Problems

Plants with such spinning reserves present some design and operating problems for auxiliaries. In the first place, the spinning turbine must assume load up to its full capacity in an outage. At times, this capacity may not be sufficient to carry the load on the system and the frequency drops. This results in slowing down of all motor driven auxiliaries such as boiler feed pump, circulating pumps, forced and induced draft fans and other auxiliaries. The decrease of fan speeds lessens the speed of pick-up of load by the boiler. The boiler feed pump may no longer have sufficient head at the slower speed to deliver water into the boiler drum. Circulating pumps may also get into difficulty.

In some of the Western stand-by plants, this situation has been met by the installation of a house turbine generator, often non-condensing, built for quick starting in an emergency. Such a unit in one plant can be started from cold condition by push button control and is automatically synchronized as it rapidly comes up to speed in a matter of seconds.

How Supply Auxiliary Power?

When the Harbor Plant of the City of Los Angeles was designed, studies were made of the most economical method of providing assured auxiliary drives. All steam drives were found uneconomical and required increased boiler capacity. Dual drives were too expensive. Non-condensing house turbines would require large quantities of steam at the time that this steam would be most needed by the main turbine.

The best solution appeared to be the installation of a 4000-kw condensing house turbine generator to exhaust into the main unit's

condensers. This auxiliary unit would operate all the time and would carry all essential motor-drive auxiliaries. This house generator is not tied in with the utility's power system and its frequency is maintained regardless of system fluctuations. As a result of its good economy, the steam demands on the boiler would be little greater than if the same power were taken from the main unit. At the same time the full output of the main unit up to 75,000 kw is made available to the system in emergencies.

Circulating and Feed Pumps

Circulating pumps are generally operated at capacity with a spinning turbine. In some cases, where two pumps are installed, one may be run during spinning operation but the other must be available for quick starting and with an automatic check valve or other device to assume rapid water delivery upon starting up.

The boiler feed pump in operation with the spinning unit may be capable of feeding the boiler at full capacity or two units may be required. At any rate, service is not instantly demanded of the boiler feed pump, for the "swell" in the boiler water when an outage occurs and where large water-wall surfaces are provided, postpones the demand for feedwater for a number of seconds. This, together with the allowable water level drop in the boiler drum, would enable an additional pump to be put into service.

Boiler Response

A spinning turbine will pick up load in an outage as fast as the governor can open up the inlet valves. The response of the boiler to this sudden addition of load is a different matter. The sudden demand for steam results in a drop in boiler pressure. As in the case of Los Angeles, the accumulator effect on the water contained in the whole boiler circuit permits the evolution of the additional steam required by the turbine at the expense of the heat of the liquid of the boiler water. The extent to which this accumulator effect can be utilized depends upon the permissible drop in boiler pressure and the speed with which the induced and forced draft fans can be accelerated and the fuel supply augmented. Any automatic system of boiler control would require an appreciable time interval to bring the motors and fans up to speed without an undue demand on the auxiliary power supply. In other words, time is necessary to accelerate these fans and motors as well as to increase gas velocities. The increase in air supply must be coordinated with the fuel feed in order to avoid uneconomical operation.

Fuel Supply

Where stokers are used, a bed of incandescent fuel would respond instantly to added air supply, though there would be some delay in boiler response due to the "soaking-up" effect of wall refractories and boiler parts.

The problem is different with other forms of supplying fuel. With powdered coal, more pulverizers would have to be put into service or at least more burners would have to be started. The coal feeders would have to furnish more coal to the pulverizers. In any case, there would be some delay in furnishing full fuel capacity.

Oil burners and gas burners can be put in operation more rapidly than powdered coal. Available systems of oil supply maintain oil pressure up to the burners. These burners can be arranged to be cut in automatically by the control system as additional air is supplied to the furnace.

Boiler Control

The automatic boiler control system must function in a certain sequence. The demand for steam will cause a drop in boiler pressure. The control then speeds up the induced draft fan. This is followed by acceleration of the forced draft fan and its added fuel supply. This sequence follows step by step until full fuel burning capacity to meet the steam demand is reached and also to restore boiler pressure to its normal value. After that, the system functions in the usual way. In removing load, the system functions in the opposite manner; that is, fuel and air are first reduced, followed by slowing down of the induced draft fan.

In the case of the Los Angeles plant referred to above, the authors state that a sudden increase in load from 5000 to 65,000 kw would require from 20 to 25 sec to increase the firing rate to full capacity. This requires a range of input to the fans from 7 per cent to 150 per cent of the amount required at 65,000 kw load on the main generator. A special Ward-Leonard control enables the fans to respond rapidly to such a change of rating. In fact, quick pick-up in the fans and their proper co-ordination with fuel supply presents one of the most difficult problems in the operation of a spinning turbine, especially in a one-turbine-one-boiler installation.

Conclusions

The spinning turbine has a place in many power systems particularly in connection with distant hydro-electric plants. Its use presents many problems, particularly when high pressure and high temperature steam must be used. Also, where operation of a spinning reserve is contemplated, a special design of boiler, with large accumulator effect, and of auxiliaries capable of rapid acceleration, must be provided. Finally, the economics of such a plant requires high efficiency under light load operation to reduce stand-by losses and, at the same time, the use of liberal clearances or other devices to enable the unit to respond freely to rapid temperature changes. In general, the design of such a station is not simple and requires much skill and ingenuity.

Sixteen-Place Table of Natural Logarithms

A NEW VOLUME in the series of mathematical tables prepared by the Work Projects Administration for the city of New York under the sponsorship of the National Bureau of Standards, is now available. This, the tenth volume to be made available through the Bureau, contains 16 decimal-place values of the logarithms of the decimal numbers from 0.0000 to 5.0000, at intervals of 0.0001. Two previous volumes of logarithms, all to 16 places, have dealt with the integers from 1 to 50,000 and from 50,000 to 100,000.

These tables are convenient for engineers and computers who have frequent use for natural logarithms and wish to obtain them with the least possible effort and time. For such workers the demand seems to be for a table in which the number of significant figures given in the argument is sufficient to avoid all but simple mental interpolation.

The price of the new table is $2.00, which includes postage to addresses in the United States and in countries extending the franking privilege. Orders, with remittance, should be sent to the National Bureau of Standards, Washington, D. C. The identifying symbol of this particular volume is MT10. Be sure to include this in your order.

ASME in Sixty-fourth Annual Meeting

By RALPH E. TURNER
Editor
Power Plant Engineering

With a record attendance, members pointed to engineers' achievements in supplying war materials, new industrial fields were cited, advances in high temperature surveyed, investigations in steam corrosion related, present status of fuels and furnaces discussed, new boiler water treatment explained, gas turbines evaluated, pipe failure due to graphitization was studied to determine cause

GROWTH in the activities of the American Society of Mechanical Engineers has from time to time demanded changes in the facilities for handling its annual meetings. It was fortunate that those in charge foresaw an enlarged attendance and provided for it by selecting the Hotel Pennsylvania in New York City as the place for holding the 64th annual meeting on November 28 to December 3, 1943. The attendance broke all previous records with more than 4000 taking advantage of the opportunity to get the latest information on engineering practice in the various fields of interest to members of the Society.

This society as an organization and its members as individuals have contributed extremely valuable service to the Government in its effort to supply the armed services with the materials of war. Converting industrial activity from a peace-time basis to war-time production has fallen heavily upon the engineering profession, and since the beginning of the war concentrated effort has been placed upon this work through the 18 professional divisions of the Society.

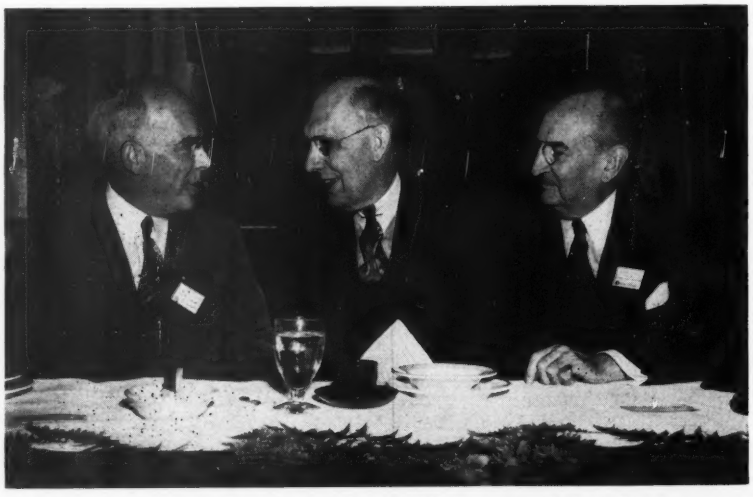
Now that industry has met its war-time production challenge and will continue to supply war materials as rapidly as the armed forces can make use of them, attention of leaders in the engineering field is being turned to that highly speculative field of postwar planning, to the planning of industrial activities that will give universal employment, advance standards of living, give to individuals directions for working out their own ideas for advancement of industrial activities in such a way as not to curb initiative.

Piercing Frontiers

This meeting could well be characterized as one having for its purpose the planning of ways and means of piercing and consolidating the frontiers of industry. Fundamental scientific research has, in past generations, been far ahead of the practical application of potentially useful facts. This gap in time is narrowing and will continue to grow less as engineering progresses in the use of recently discovered scientific facts. This process may appropriately be called the consolidating of scientific frontiers for the advancement of peacetime arts.

In his presidential address, Harold V. Coes expressed optimism regarding postwar conditions in this country but has no illusions regarding the difficult problems ahead for management and engineering. He pointed to some of the new materials for which specific uses have not yet been completely developed. Aluminum and magnesium are being produced in much greater quantities than formerly, their sources seem limitless and their use in industry to displace copper and zinc for many purposes is already taking place. New steel alloys with tensile strengths of 190,000 psi have been developed, also ferro-alloys capable of withstanding temperatures of 1100 F. The strength of copper and nickel can be raised to 185,000 psi and 260,000 psi respectively by the introduction of a very small percentage of beryllium.

New uses for X-ray are being found continuously; electronic color analyzing has possibilities not yet explored; microphotometry has simplified the analysis of molten metal; new methods of electrolytic plating offer economic advantages in that field; television will probably emerge from the war as a sizable postwar industry; the electron microscope opens up new avenues of approach to knowledge about materials, chemicals, disease and infection; new lubricants and lubricating systems for war purposes will be available for industry in the postwar period; powdered metallurgy is something for engineers to watch.



Robert M. Gates, new president ASME, Charles F. Kettering and Harold V. Coes, retiring president ASME, at luncheon meeting where Mr. Kettering, director of research of the General Motors Co., gave his reply to the question, Is It Possible to Develop Inventors?

"I have never had any patience with the idea that the industrialization of the United States is complete, that there are no new opportunities to explore and pioneer," said Mr. Coes. "I look upon these new developments as rare opportunities to progress, to develop, to raise the standard of living. Let us turn our talents and the application of these new developments to the peace time economy when it is time, but we should plan for it in advance of that time."

Twin Branch Station

Engineers in the power field have been waiting since March 1941, when the 2500-psi steam generating unit was first put into operation in the Twin Branch Station of the Indiana & Michigan Electric Co., for an account of the operating experience with that unit. A complete session of the meeting was given over to papers and discussion on this unit. Philip Sporn and E. G. Bailey gave in detail descriptions of alterations made to overcome difficulties which have developed in two years of operation. Will H. Rowand and T. B. Allardice discussed the circulation requirements of the 2500-psi boiler giving the results of studies on downcomers and on the cyclone-separator design arrangements. Distribution of heat absorption and factors affecting performance of the unit were analyzed by F. G. Ely and L. B. Schueler. These papers are presented in abstract form on other pages of this issue of POWER PLANT ENGINEERING and need no further comment here other than that the boiler has operated satisfactorily at full design values since December 1942 and has demonstrated the practicability of natural circulation in a 2500-psi boiler.

High-Temperature-Steam Corrosion

In the practical application of steam at high temperatures it was soon discovered that the rate of corrosion of metals used in steam boilers, piping and turbines varies with temperature. This fact, among others, has led to a comprehensive study of the subject in the laboratories of the Detroit Edison Co. where 46 different materials were studied under plant operating conditions. At this time the results of five years of work were reported. Samples of the materials were exposed in superheated station steam for periods ranging from 4000 to 16,000 hr. Pressure employed was 380 psi and temperatures were 925 F and 1100 F.

Test results indicate that the weight loss of plain-carbon steel exposed to 1100 F steam continues at a high rate, whereas the rate of loss of the alloyed materials decreases with time. The high chromium-nickel and the 12-chromium stainless steels were the most corrosion-resistant. Materials which corroded rapidly at 1100 F corroded only slightly at 925 F, and at this lower temperature there was little difference between the rate of corrosion of plain carbon and alloy steels.

Scientists at Purdue University recognize that steam temperatures in modern power plants and in some of the process industries are approaching and in some cases exceeding those which may be used for the production of hydrogen by reaction between steam and iron. They have therefore undertaken the measurement of the amount of corrosion on unstressed specimens due to steam temperatures up to approximately 1800 F. In the tests which have been conducted, all of the steels tested, except for the very high chromium-nickel alloys, show rapid corrosion beyond a limiting temperature which increases with chromium content.

Relatively simple empirical equations have been established to aid in computing the amount of corrosion produced in 500 hr at temperatures within the test range for the various steels tested. The investigation indicates that the chromium content of a steel is a major factor in controlling the amount of corrosion produced by high-temperature steam.

New Officers of ASME

President Robert M. Gates, president of the Air Preheater Corp.

Vice Presidents: David W. R. Morgan, Jonathan A. Noyes, Rudolph F. Gagg, Ford L. Wilkinson, Jr.

Managers: James M. Robert, Samuel H. Graf, Alton C. Chick, J. Calvin Brown

Recipients of Honors and Awards

Junior Award: Troels Warming
Worner Medal: Igor I. Sikorsky
Holley Medal: Vannevar Bush
ASME Medal 1943: Lewis K. Sillcox
ASME Medal 1940: Charles F. Kettering
Honorary Memberships:
Francis Blossom
Ralph Budd
Edward N. Trump
Roy V. Wright
Alfred Noble Prize: Benjamin J. Lazan
Gantt Medal: Dexter S. Kimball
Fritz Medal: Charles F. Kettering

EXPRESSED OPINIONS

"Whatever we have in the way of a postwar economic world, it will be what management gives us."—John R. Bangs.

*

"Present estimates indicate that individual savings by the end of 1944 may approximate $100 billions. These funds provide our greatest assurance that a market will be ready to absorb a greatly increased output of goods and services. They also constitute a very serious inflationary danger unless these goods and services are speedily forthcoming."—John F. Fennelly.

*

"The much discussed four freedoms will be meaningless unless they are implemented by economic freedom or the freedom of enterprise that has made the country great."—Dexter S. Kimball.

*

"Quality control is a 'must' job ahead of management."—C. S. Gotals.

*

"Wage incentives are particularly in need of clarification and standardization."—Ralph M. Barnes.

*

"Speedy settlement of terminated contracts will be necessary to free working capital and to clear plants of wartime inventories and equipment."—John F. Fennelly.

*

"We may expect to see increasing efforts made to provide opportunity in proportion to ability on a much wider scale in the future."—Henry T. Heald.

*

"The most significant accomplishment in the rubber industry during 1943 was the virtual completion of the synthetic rubber production program."—John W. Liska.

*

"Many engineers have hesitated to use electronic devices because they were unfamiliar in appearance and operation."—W. B. Cockrell.

*

"The foundation of any incentive payment is to make the worker feel that he is part of the team and profits proportionately from the success of the organization."—James F. Lincoln.

*

"In the postwar period standardized structural sections made from high strength plastics may be used in building because of their resistance to corrosion, probable greater speed of assembly due to light weight, and natural insulation properties of these materials."—Charles F. Marchner.

*

"I can think of no more ingenious method for mass production than the testing for hardness and roundness of millions of balls used in ball bearings than bouncing and rolling them on steel plates."—W. L. Merrill.

*

"The use of instruments has created a demand for men trained in their servicing and operation."—G. P. Bosomworth.

*

"Substitutions forced upon industry by our present day world conflict have resulted in the development of many products of improved utility."—T. A. Cohen.

Papers of Interest to Power Engineers

Operating History of the 2500-psi Twin Branch Plant, Philip Sporn and E. G. Bailey

Natural Circulation Test Results in the 2500-psi Twin Branch Boiler, W. H. Rowand and T. B. Allardice

Distribution of Heat Absorption and Factors Affecting the Performance of the Twin Branch 2500-psi, 940 F Boiler With Reheat to 900 F, E. G. Ely and L. B. Schueler

Furnace Design and Development of Steam-Generating Units Burning Central Illinois Coal, J. R. Michel

Collection of Data on Existing Installations, Philip Sporn

Pulverized-Coal-Fired Boiler Furnaces, Public Service Electric and Gas Company, New Jersey, Herman Weisberg

Description and Performance of Boilers 12 and 14, Trenton Channel Plant and Boilers 9 and 10, Marysville Plant, R. J. Brandon and W. A. Carter

Statistical Information on Large Pulverized Coal Units on Consolidated Edison System, W. E. Caldwell

Performance of Pulverized-Coal-Fired Boilers on Philadelphia Electric Company System, James H Harlow

Heat Transfer to Water-Cooled Furnace Walls, Henry Kreisinger and R. C. Patterson

Absorpiton of Heat by the Walls of a Furnace, John Blizard

The Flow Characteristic of Coal-Ash Slags in Solidification Range, W. T. Reid and P. Cohen

Combustion of the Barley Size of Anthracite, Allen J. Johnson

New Combustion Control Methods for All Standard Fuels, Robert Reed

Combustion in High-Pressure Chambers, Eric, G. Peterson

An Evaluation of the Importance of Physical and Chemical Properties of Fly Ash in Creating Commercial Outlets for the Material, C. M. Weinheimer

Fuel and Its Research in Great Britain During the War, W. C. Schroeder

High-Temperature-Steam Corrosion Studies in Detroit, I. A. Rohrig, R. M. Van Duzer, Jr., and C. H. Fellows

The Corrosion of Alloy Steels by High-Temperature Steam, G. A. Hawkins, J. T. Agnew, and H. L. Solberg

A New Approach to the Problem of Conditioning Water for Steam Generation, R. E. Hall

Graphitization of Carbon-Molybdenum Steel on Tubular Creep Tests, H. J. Kerr and F. Eberle

Carbon Instability of Carbon-Molybdenum Steel Piping, R. W. Emerson

Possible Means for Avoiding Localized Graphitization in Carbon-Molybdenum Welded Pipe, George V. Smith and Richard F. Miller

Report of Joint AIEE-ASME Committee on Tentative Specifications for Speed Governors

Theoretical Regenerative-Steam-Cycle Heat Rates, A. M. Selvey and P. H. Knowlton

Fluid Flow Through Two Orifices in Series, M. C. Stuart and D. Robert Yarnall

Investigation of Blade Characteristics, John Weske

Notch-Toughness Tests of Carbon Molybdenum Pipe Materials, W. F. Kinney, I. A. Rohrig, and H. S. Walker

Hydraulic Torque Converter, A. Lysholm

Mechanical Details and Performance Tests on 30,000-hp Glenville Unit, the East's Only Large Impulse Turbine, Arnold Pfau

Efficiency Analysis of Pelton Wheels, Robert Lowy

Maintenance of Hydroelectric Generating Units, G. H. Bragg

Hydraulic Turbine Maintenance, R. R. Woodman

Future for Diesel Engine Fuels, Arch L. Foster

The Smith Master-Valve Engine and Its Performance, Byron E. Short and T. M. Smith, Jr.

Heat Effects in Lubricating Films, A. C. Hagg

Use of Rubber in Power Drive Lines, James N. Booth

In the design of liquid flow control equipment, need has arisen for more data on the flow of a fluid through two orifices in series. The problem of supplying at least some of these data has been attacked by Milton C. Stuart and D. Robert Yarnall who gave results of experimental investigations on this subject using water at an initial pressure of 100 psia and over a range of temperatures from room temperature to saturation temperature. One of the most significant facts revealed is that under certain conditions of flow the fluid assumes a metastable state which greatly influences the characteristics of the process.

Piping Materials

Materials for high temperature steam piping are gradually being developed and tested so as to make the use of higher temperatures safe in practice. Among the pioneers in this advanced practice is the Detroit Edison Co. from whose laboratories have come a vast amount of data found helpful in the practical application of high pressures and high temperatures. One of the latest studies was reported by W. F. Kinney, I. A. Rohrig and H. S. Walker which had to do with tests of carbon-molybdenum pipe material. The specific problem studied was to determine the influence on the uniformity of test results and on the magnitude of average notch-toughness values both at room temperature and at 925 F, of three variables, namely, the type of specimen, the heat of steel and the condition of the steel. The authors conclude that when the significance of notch-bar testing of carbon-molybdenum pipe material is fully understood, it may be possible to select material of the best quality for high temperature service on the basis of notch-bar tests.

Fuels

The fuels available to industry today are considered among the most valuable of raw materials and every means possible is being used to conserve them. Such information as given by Allen T. Johnson on the combustion of barley anthracite is very helpful in securing the most heat out of this type of fuel. His paper was divided into three parts, the first dealing with the preparation, quality and characteristics; the second with the effect of coal size and quality upon boiler performance; and the third with the equipment available for burning barley anthracite. In summarizing, he gave rules for the economical use of this fuel.

In Great Britain the fuel situation is extremely critical and has been ever since the beginning of the war. W. C. Schroeder of the U. S. Bureau of Mines has recently made a first hand study of this situation and reported that the war period has fostered considerable planning for the future that will affect British policy to a marked extent after the war. Some of the primary items of immediate importance, he stated, are the development of automotive gas producers, effect of the war on coal production, the fuel-economy campaign, development of efficient fireplaces, and the study of colloidal fuel. Three of the long-range items are correlation of coal properties with heat of wetting and reflective indexes and the production of liquid fuels from coal.

Furnace Performance

No session of the meeting drew a larger audience nor more worth while discussion than that arranged under the auspices of the research committee on furnace performance factors with cooperation of the fuels, power and heat transfer divisions. At this session, under the chairmanship of E. G. Bailey, six engineers representing different utility power companies discussed various phases of furnace performance which they had encountered in their plants.

John R. Michel dealt with furnace design and development of steam-generating units burning central Illinois coal relating specifically to experience gained since 1929 at Crawford Station of the Commonwealth Edison Co. of Chi-

cago, concerning problems of slag-fouling of steam-generating tube banks and superheaters.

Facts learned as a result of this experience have been used in the design of several pulverized-coal burning units at company plants in Chicago, some of these high capacity boilers generate steam at 1325 psi, 935 F. The fundamental governing factors in attaining installations which perform satisfactorily with this fuel were stated to be low furnace heat release, relatively low entering gas velocities to convection tube banks, furnace gas temperature below the softening temperature of the ash where gases enter the convection banks, proper disposal of heat absorbing surfaces to allow adequate installation of mechanical blowing equipment, and provision of hand lancing doors so arranged that all heat absorbing surfaces can be manually cleaned in the event of failure of the mechanical blowing equipment.

Philip Sporn presented a collection of data on existing installations being operated by the American Gas & Electric Service Corp.

Statistical information was given by Herman Weisberg on pulverized-coal-fired boiler furnaces operated by the Public Service Electric & Gas Co. of Newark, N. J., together with reasons for the various designs described. He expressed the opinion that fundamental research on the factors involved is needed if we are to have more economical installations and take care of the higher pressures and higher temperatures of future power cycles.

It was reported by R. J. Brandon and W. A. Carter that at the Trenton Channel Station of the Detroit Edison Co. no serious slagging on the tube surfaces has occurred when burning coals having ash-softening temperatures of 2500 F or higher. Problems of ash accumulations on the hearth-screen tubes and slagging of the refractory furnace walls were mentioned. Methods employed at the Marysville plant for reducing slagging of water-wall tube surfaces were also described.

W. E. Caldwell presented statistical information on the operation of large pulverized-coal units on the Consolidated Edison Co. system.

Three types of pulverized-coal fired boiler units in operation by the Philadelphia Electric Co., each rated at 600,000 lb of steam per hr, were described by James H. Harlow. It was reported that the problem of a very rapid loss of metal from furnace wall tubes was acute about two years ago. Several changes in furnace design have been made to correct this difficulty. Several theories have been advanced as to the mechanism of the wastage but the matter still remains a subject for investigation.

C. B. Campbell, Westinghouse, So. Phila., T. E. Purcell, Duquesne Light Co., Pittsburgh; P. W. Thompson, Detroit Edison Co.; N. E. Funk, Philadelphia Electric

Water Conditioning

In a treatise on a new approach to the problem of conditioning water for steam generation, Dr. R. E. Hall stated that in 1942 his organization inaugurated the drastic change of maintaining the boiler water on a potassium equilibrium, in place of a sodium equilibrium which has characterized boiler water from the beginning of steam generation. The paper included a discussion of problems relating to magnesium deposits, hide-out of boiler-water salts, corrosion by the bonded oxygen of the boiler water, silica in boiler and turbine, equilibrium developed in the superheater in any carry-over of boiler water, and protection from embrittlement. Dr. Hall is confident that his logical approach to the problems of the steam-water interfaces will give to the engineers those cleaner surfaces for the boiler-tube raceway which will bring calculated and actual circulation into better agreement.

Gas Turbines

For several years engineers as well as manufacturers have been watching with extreme interest the developments taking place which point to a wider application of the gas turbine for power generation. Dr. Sanford A. Moss, whose long experience in the development of the turbosupercharger has placed him in close touch with the gas turbine situation, stated that "the long-sought gas-turbine prime mover, with temperatures much beyond the 1000 F now in use, seems to be getting nearer. Of course this same progress is paving the way to higher temperatures and higher efficiencies for the regular steam cycle and the two-fluid cycles. So we can only speculate as to whether the gas turbine with its compressor, a combustion chamber, and a heat interchanger is going to compete with the other cycles which instead have economizers, feedwater heaters, feed and air pumps, boilers and condensers."

Graphitization of Steel Pipe

One of the most informative sessions of the meeting was that devoted to a discussion of the graphitization of steel pipe. Contributing to this discussion were three papers, one by Howard J. Kerr and F. Eberle, both of Babcock & Wilcox Co., the second by R. W. Emerson of Pittsburgh Piping and Equipment Co., and the third by George V. Smith and Richard F. Miller, both of the U. S. Steel Corp.

Interest in this subject was particularly acute because of a steam-pipe failure several months ago at the Springdale power generating station of the West Penn Power Co. which resulted from excessive local graphitization and examination of other steam lines has revealed similar instances of local graphitization. The fracture mentioned occurred suddenly around the whole periphery of a 12¾ in. o.d. by $1\frac{7}{16}$ in. wall, aluminum killed, carbon molybdenum steam pipe at a distance of approximately $\frac{1}{16}$ in. from the border of the fusion zone of the weld by which it was joined to the main steam header of the boiler. The reported welding conditions comprised a 400 F preheat and a subsequent stress-relief treatment of three hours at 1200 F. The pipe had been in service for 5½ yr at a steam temperature and pressure of 935 F and 1300 psi, respectively.

The Stabilized Circulating Cycle for Forced Circulation Boilers*

In circulating pumps for such boilers, NPSH relatively low . . . if boiler pressure and temperature vary, pump suction may flash . . . new Worthington cycle developed to eliminate this problem . . . lowers vapor pressure of feedwater entering circulating pump . . . system by-passes part of water flow from economizer and feed pump through circulating pump . . . orifices control by-pass flow . . . feed pump is protected . . . charts show temperature—NPSH relations . . . alternate cycle has by-pass proportioning valve . . . ingenious new automatic controls for this valve are fully described

By Igor J. Karassik — *Application Engineer, Worthington Pump & Machinery Corporation*

THE FORCED CIRCULATION BOILER has, in the opinion of a number of power plant engineers, certain marked advantages over the natural circulation boiler, especially where space limitations present a definite problem with respect to the arrangement of the heating sections and to the steam generated per unit of space and weight. Such conditions occur, for example, in the marine field as well as in the application of large steam power units to locomotive propulsion. Some engineers foresee a great deal of interest in forced circulation boilers after the war, as a means for increasing steam capacity in existing boilers, if it should prove feasible to convert such boilers to forced circulation. However, the present study does not intend to enter into an evaluation of the forced circulation versus the natural circulation boiler but, rather, concerns itself with some of the pumping problems in connection with forced circulation.

Circulating Pump Suction Pressure

The first problem centers in the fact that a boiler circulating pump takes its suction from the boiler drum at a pressure and temperature corresponding to the temperature and pressure in the boiler drum at saturation. This means, for instance that a 1200-psi boiler would impose a pressure of 1200 psi and a temperature of approximately 569 F on the suction of the circulating pump. Hence very severe stuffing box problems are encountered in the application of centrifugal pumps to forced boiler circulation. A great number of solutions, some of them very ingenious, exist today to solve this particular problem. While such solutions are workable, it is probable that none of them is final and that the matter is subject to further improvements—especially in the higher pressure brackets.

The second difficulty involves the fact that the circulating pump has a relatively limited net positive suction head over the vapor pressure, this net suction head being obtained by placing the boiler circulating pump at some lower level than the surface of the liquid being withdrawn from the boiler. In addition, boiler circulating pumps are generally designed to handle a capacity of from five to eight times the maximum boiler feeding capacity. Thus the capacity of such pumps is relatively large in comparison to the boiler feed pump capacity and the circulating pumps must operate at relatively low speeds, resulting in large units and high cost.

Pump Suction Temperature and Vapor Pressure Relation

Finally, it is necessary to take into consideration the fact that boiler pressures and temperatures do not stay pegged at an exact value but undergo a certain amount of fluctuation. The danger exists that, if the boiler pressure should drop suddenly by a few pounds, the boiler circulation pump might flash because the water at the pump suction would still be at the temperature of saturation at the former boiler pressure. This tendency increases very rapidly as boiler pressures rise. For example, a decrease of 1 F at a boiler pressure of 400 psi means a reduction of only 3.8 psi, while the same temperature reduction in a 1200 psi boiler corresponds to a pressure drop of almost 9 psi.

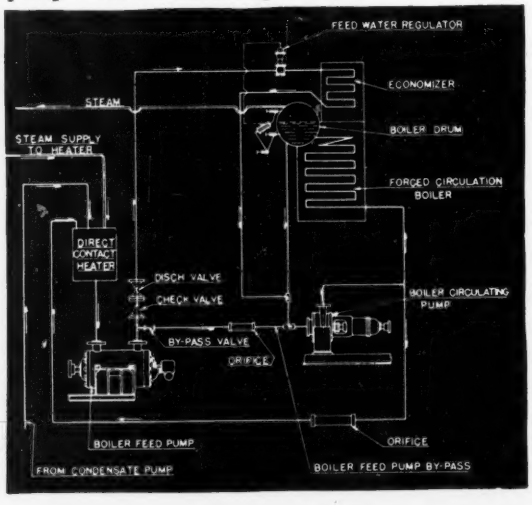


Fig. 1. Diagram of Stabilized Boiler Circulating Cycle for forced circulation boilers. Water is delivered from economizer to circulating pump suction instead of to boiler drum. This pump handles sum of boiler feed flow and flow from drum. But boiler feed is under control of water level regulator. Also some of boiler feed, controlled by orifices, is by-passed from feed pump through circulating pump, reducing vapor pressure at suction and back to heaters, protecting feed pump. By-passes are operated as in conventional boiler feed cycle.

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It is this second problem that the Stabilized Boiler Circulating Cycle (patents pending) is intended to eliminate. To obviate the disadvantages presented by the conventional arrangement of forced circulation boiler systems, the Stabilized Cycle provides for the lowering of the temperature and, therefore, the vapor pressure of the feedwater entering the pump.

Details of New Stabilized Cycle

This boiler circulating system is illustrated schematically in Fig. 1. In this diagram, it will be seen that the delivery from the boiler feed pump proceeds into the economizer (assuming that this is provided in the boiler) and, instead of entering the boiler drum directly, is then led through a connection to the suction of the boiler circulating pump itself. The latter handles a total flow made up of the sum of the boiler feed flow and of the flow through the downcomer from the boiler drum. It will be seen also that it is immaterial, from the point of view of feedwater supply, whether the boiler feed pump delivers directly to the boiler drum or to the suction of the boiler circulating pump, inasmuch as the feedwater regulator in the discharge of the boiler feed pump is still governed by the boiler water level.

By-pass Protection at No Flow

It must be remembered, however, that the flow from the boiler feed pump does not necessarily remain constant. Periods occur when the boiler feed flow is considerably reduced and it may even be considered that at times it will be completely interrupted. In order to provide against such an eventuality, the boiler feed pump by-pass, which must ultimately return to the direct-contact heater at the suction of the boiler feed pump, is instead also returned to the boiler circulating pump suction. The amount of boiler feed by-pass is controlled by the conventional inclusion of an orifice. In order to prevent flooding of the boiler through the addition of the pump by-pass to the flow from the boiler drum, a second by-pass is provided from the discharge of the boiler circulating pump, this by-pass leading back to the direct-contact heater.

A second orifice is provided in this second by-pass line, the function of the second orifice being to limit the amount of the final by-pass to that passing through the first orifice. These by-passes do not have to be operated at all times but rather in the same manner as they would be operated in a conventional boiler feed cycle. In other words, they would be opened whenever the boiler feed pump capacity falls below a predetermined minimum permissible quantity and closed again when flow through the boiler feed pump is restored to a normal value.

Calculating Temperature Depression

The very same factors which led to dangerous conditions in the event of a sudden temperature drop in the boiler act to provide reliability in the operation of this cycle even with a moderate, almost negligible temperature depression at the circulating pump suction. The value of the temperature depression obtained under any given operating conditions can be easily calculated as follows:

$$T_3 = \frac{(Q - q)\,T_1 + q\,T_2}{Q}$$

where:

T_3 = Temperature at circulating pump suction
Q = Total required flow through circulating pump
q = Flow of injected cooler feedwater
T_1 = Saturation temperature in the boiler drum
T_2 = Temperature of injected feedwater

so that the temperature depression

$$dT = T_1 - T_3 = \frac{q}{Q}\,(T_1 - T_2)$$

The chart in Fig. 2 gives the resulting temperature depression in terms of the temperature difference between the downcomer and the injected feedwater and of the ratio between the injected and the total flows. The effective increase in net positive suction head for a given temperature depression and at a given boiler drum saturation temperature is plotted on Fig. 3.

Thus, for instance, if it is assumed that it is desired to provide 125 ft surplus NPSH (net positive suction head) for an installation involving a 900 psi boiler (saturation temperature = 534 F approx) then the required temperature depression is only 5 F. Assuming further that injection feedwater is available at a temperature of 300 F, so that the difference between the saturation temperature in the drum and the temperature of injection is 234 F, the ratio of injected flow to the total flow of circulation needs be only 0.021, or just over 2 per cent.

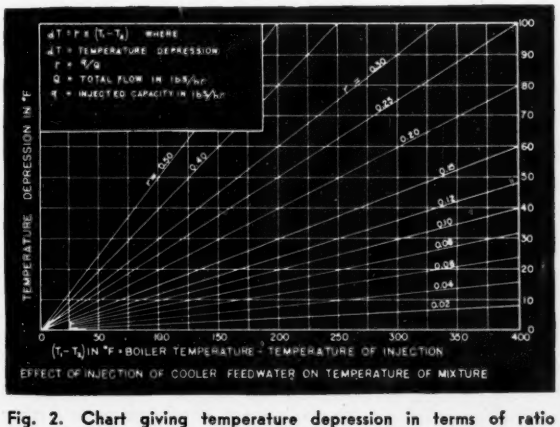

dT = r x (T1 - T2) WHERE
dT = TEMPERATURE DEPRESSION
r = q/Q
Q = TOTAL FLOW IN lbs/hr
q = INJECTED CAPACITY IN lbs/hr
TEMPERATURE DEPRESSION IN °F
(T1 - T2) IN °F = BOILER TEMPERATURE - TEMPERATURE OF INJECTION
EFFECT OF INJECTION OF COOLER FEEDWATER ON TEMPERATURE OF MIXTURE

Fig. 2. Chart giving temperature depression in terms of ratio between injected feedwater flow and total boiler water flow through circulating pump

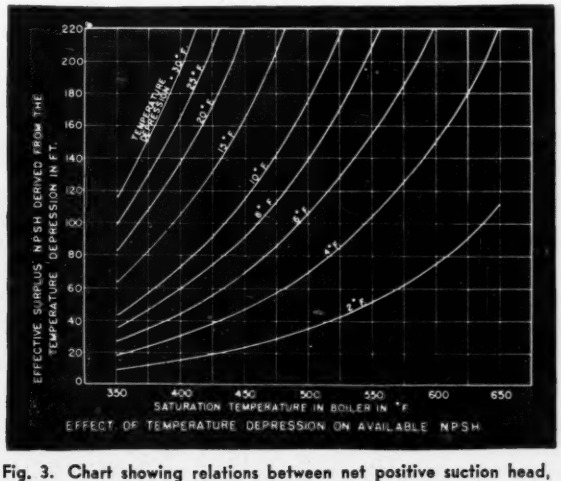

EFFECTIVE SURPLUS NPSH DERIVED FROM THE TEMPERATURE DEPRESSION IN FT.
TEMPERATURE DEPRESSION
SATURATION TEMPERATURE IN BOILER IN °F
EFFECT OF TEMPERATURE DEPRESSION ON AVAILABLE NPSH

Fig. 3. Chart showing relations between net positive suction head, NPSH, at circulating pump, temperature depression and drum saturation temperature

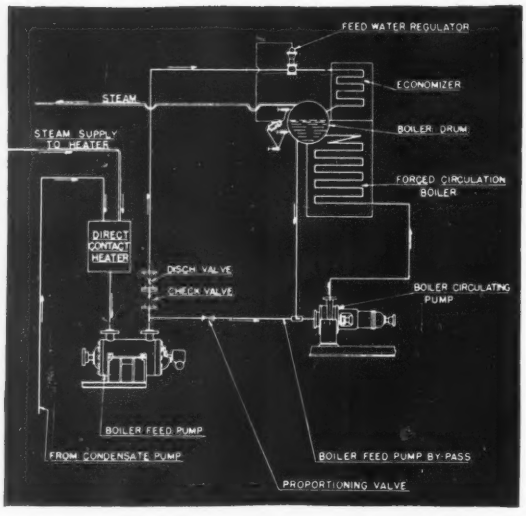


Fig. 4. Alternate arrangement of Stabilized Boiler Circulating Cycle showing proportioning valve controlling feed pump by-pass instead of orifice of Fig. 1. Since the by-pass is open at all times, no second by-pass is required to protect the feed pump from overheating, provided minimum by-pass flow through pump is correctly calculated

This analysis leads to the conclusion that it may not be always necessary to introduce the entire boiler feed pump delivery into the suction of the circulating pump.

Alternate Arrangement of Cycle

As a matter of fact, it may be more advantageous in certain cases to withdraw the injected feedwater before it has passed through the economizer or even the closed heaters on the discharge side of the feed pump. Outlet temperatures from economizers may be quite high and, in some cases, practically at the saturation point. Likewise, withdrawing the feedwater ahead of the closed heaters increases still further the difference between the saturation temperature and that of the injected feedwater. An alternate arrangement, therefore, is contemplated for the Stabilized Boiler Circulating Cycle, as illustrated in Fig. 4.

In this arrangement, the boiler feed pump discharge is led to the boiler drum in the conventional manner. A by-pass, located *ahead* of the check and discharge valve, leads into the suction of the circulating pump. The flow through this by-pass is calculated in such a manner that the resulting temperature depression provides the desired surplus NPSH. Incidentally, since this by-pass is to remain open at all times, there need be no further provision for another by-pass to protect the boiler feed pump against overheating.

Necessary Precautions

There are but two precautions to be observed. The first of these is to check whether the by-pass flow, figured on the basis of the required temperature depression, is sufficient to avoid operation of the feed pump with an excessive temperature rise. The second is to provide a means to dispose of excess feedwater in case the feedwater regulator should call for no flow into the boiler.

It is generally the practice to limit the temperature rise through a boiler feed pump to not over 15 F and in order to accomplish this, the minimum permissible flow through the pump can be approximated to a value of 15,000 lb per hr per 100 Bhp at shut-off. Thus, the minimum flow through the injection by-pass in Fig. 4 should be selected as equivalent to the greater of the two flows determined on the basis of feed pump protection against overheating or of the required temperature depression respectively.

New Control for Proportioning Valve

The proportioning valve in Fig. 4 may be controlled manually or automatically. Automatic control is by means of a new type of automatic mechanism for controlling the margin between the pressure at the suction of a pump of the vapor pressure corresponding to the pumping temperature. (Patents are likewise pending on this mechanism). Two forms of control have been developed for this mechanism.

One of these is illustrated in Fig. 5. A temperature sensitive bulb is used to measure the temperature at the point desired, transmitting variations of internal pressure due to temperature changes through capillary tubing and a specially constructed bellows to a movable indicating pointer. The bellows is so calibrated that the pointer moves along an indicating scale that reads the vapor pressure corresponding to the temperature. A further feature of the pointer travel is that the amount of travel per unit of pressure change is independent of the absolute value of the actual vapor pressure measured. A similar bellows and pointer device is connected to the absolute pressure measuring device and possesses the same features with respect to travel per unit of pressure change.

Thus, the distance along the scale between the two pointers represents (at all temperatures and pressures) the net difference between the absolute pressure at the point of measurement and the vapor pressure corresponding to the feedwater temperature at that point. An extension arm is attached to the pointer indicating the vapor pressure, the length of this extension arm representing the minimum permissible pressure margin between the suction pressure and the vapor pressure. If an electrical circuit is established, with individual connections at each of the two pointers, the circuit would remain open as long as the available pressure difference (NPSH) remained in excess of the minimum desired pressure margin. Upon lowering of the pressure margin to the minimum permissible, the extension arm would make contact and close the circuit. The opening and closing of the electrical circuit is then applied to actuating a motor-driven modulated-type proportioning valve.

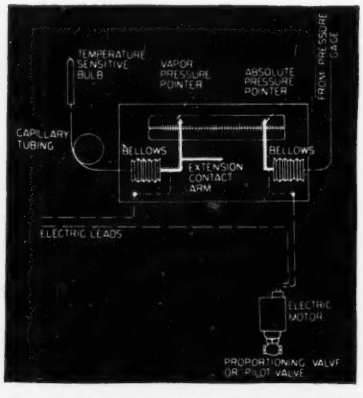


Fig. 5. New type of automatic control for proportioning valve of Fig. 4, to control margin between circulating pump suction pressure and vapor pressure corresponding to pumping temperature

Control May Be by Diaphragm Valve

The desired control for the proportioning valve may also be obtained by means of a spring-loaded diaphragm valve as illustrated in Fig. 6. One side of the diaphragm is loaded with the absolute pressure at the pump suction, while the other side is subjected to the vapor pressure corresponding to the feedwater temperature at the pump suction. The desired pressure margin between these two pressures determines the size and tension or compression of the loading spring of the valve. Obviously, this valve can be used either as a direct-operating valve or as the pilot valve controlling a larger proportioning valve by means of air, water or oil pressure.

A by-pass must be installed in the discharge of the circulating pump to dispose of excess capacity which would accrue to the boiler if the feedwater regulator should call for less flow than is delivered through the cooling injection connection. This by-pass may lead to the direct contact heater as shown in Fig. 1, to the make-up evaporator or to the hot process softener.

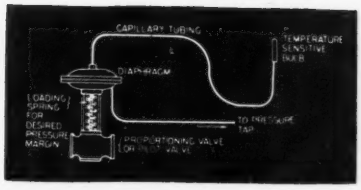


Fig. 6. Proportioning valve of Fig. 4 may be controlled by this arrangement of a diaphragm valve, used as a direct-operating valve or as a pneumatic or hydraulic pilot valve

Welding Training Films

By Lyne S. Metcalfe

IN ORDER to speed up the training of apprentice welders in connection with the war production training program in industry and vocational schools, a new series of 15 slidefilms (or filmstrips) has been made available which cover the entire range of the welding art.

This is one of many slidefilm kits which have been provided to train new workers in the arts and crafts now most needed in the winning of the war. It is not the purpose of these pictures alone to take beginners and make skilled welders out of them. Rather the aim is to more quickly give the student a basic knowledge of welding equipment, welding, and welding technique. Each film is the basis for a single lesson which, in each case, is followed by actual shop demonstration and torch practice. The picture screen has proved its ability to convey even complex facts and ideas to beginners much more rapidly and clearly than is possible by the use of lectures or text book study. With pictures "they see what you mean—instantly."

Many large industrial plants will use these pictures in their welding schools, and the slidefilms are also being widely used in vocational classes in high schools and colleges, in connection with the nationwide, Government-sponsored industrial educational program.

For those not familiar with the slidefilm medium, it may be said that this is a "reading" or "discussional" type of slidefilm—in other words a strip of 35 mm safety motion picture film, with explanatory text, labels, letterings, legends or notations superimposed on the film. The specific purpose of this form of film is to permit the instructor to read or speak without interferences, and to permit students to talk if desired—supplying illustrated material in illuminated form for class participation, and to encourage discussion.

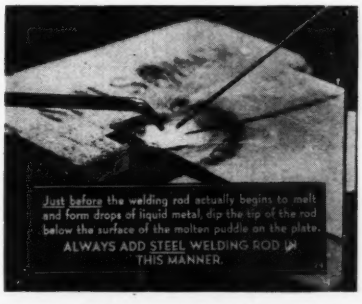
Pictures can be thrown up in illuminated form on any screen or wall as big as you want them. Pictures will stand as long as is necessary for discussion, or question and answer sessions.

In the large welding shop, these slidefilms are being used by skilled welders to train newcomers, the procedure being, as a rule, to hold one lesson for each slidefilm subject, and then pass on for actual shop practice under the guidance of the instructor. In many cases exams are given at the end of each lesson to check up students' progress and understanding.

Subjects covered in the new Welding Kit-set are:

An Introduction to Welding (Oxyhydrogen and oxyacetylene welding, pressure gages and torches, safety); *Setting Up and Lighting the Welding Torch; Welding Flat Ripple; Flat Butt Welds* (Preparation, procedures, inspecting weld, tests); *Fillet Welds — Steel; Vertical Welds—Steel* (Vertical fusion welding, lap welding, fillet welding, cross welding, inspection); *Tube Welds—Steel; Cluster Welds; Oxyacetylene Cutting* (Cleaning and preparing the cut, preparing cutting torch, safety); *Welding Stainless Steel; Brazing and Silver Soldering; Welding Aluminum Flat Sheets* (Characteristics of aluminum, uses of flux, making tack welds, butt weld, lap weld and wandering welds); *Welding Aluminum Sheets with Tubes; Fuel and Oil Tank Repairs; Qualification Test for Welders.*

There is a total of 742 individual pictures, charts, diagrams, photos, drawings and exhibits in the series of 15 slidefilm subjects.


Just before the welding rod actually begins to melt and form drops of liquid metal, dip the tip of the rod below the surface of the molten puddle on the plate.
ALWAYS ADD STEEL WELDING ROD IN THIS MANNER.

Typical slidefilm showing welding technique

ANOTHER CASE of increased production for the war effort through installation of capacitors was recently reported. The plant's transformers were operating at 85 C and action of some kind was imperative. Westinghouse engineers who supervised the installation of capacitors, point out that the expense was not justified on the basis of power factor alone. However, considering the loss of production necessary to install additional power-handling facilities by the usual means, the capacitors proved by far the best solution for the problem.

SAVING of nearly 35 tons of steel was made recently in the construction of a Westinghouse 6000-kw motor-generator set. Instead of the usual construction consisting of two 3000-kw units, the machine was made up of three 2000-kw units. Operation at 505 rpm instead of 352 rpm was thereby possible. At the higher speed an 85,000-lb flywheel provides the same stored energy as the 154,000-lb flywheel does at 352 rpm. Besides the saving in the flywheel, the smaller, higher speed generators require less copper, steel and other material.

SPLICES IN COTTON BELTS have never been satisfactory for high-speed power transmission applications. The leather shortage has resulted in the development of a new waterproof cement which, according to Westinghouse experts, makes a smooth, permanent splice.

The 2500-psi Twin Branch Plant—*Operating History**

By

PHILIP SPORN, *Vice President and Chief Engineer, American Gas & Electric Service Corporation*

and

E. G. BAILEY, *Vice President, The Babcock & Wilcox Co.*

Twin Branch operation since March, 1941, divided into three periods, with two main outage intervals . . . planned program of changes, based on operating experience . . . details of changes made in boiler . . . turbine and boiler feed pump operation . . . tests and operating results . . . the 2500-psi unit gives 96.7 per cent availability, 10,035 Btu per kwhr, thermal efficiency of 34.0 per cent

MORE THAN 6 years ago, a 2500-psi steam-electric generating unit was projected for installation at the Twin Branch Plant of the Indiana & Michigan Electric Company. After much study, thought, and intensive effort, the project was placed in operation in March, 1941.

Figure 1 gives a graphic history of the operation of this high-pressure unit. The total time since the unit was first placed on the line divides itself into three periods. The first period started May 5, 1941, the date the unit was placed back on the line after preliminary adjustments and inspections, and ended February 13, 1942. The boiler arrangement during this period is shown in Fig. 2. The second period started April 29, 1942, and ended August 14, 1942, and had the arrangement shown in Fig. 3. The third period started October 1, 1942, and after changes to circulation and very minor changes to surface, as shown in Fig. 4, has continued up to the present.

In that entire period two main outage intervals were experienced during which substantial changes were made in one or more parts of the boiler. Both of these periods, however, were scheduled months in advance of the time when the unit was actually taken out. In other words, the difficulties encountered were such that they could have been endured. There was a period of some 3 months when the unit was operated at a pressure of approximately 1750 psi. But since the changes that were completed on October 1, 1942, the unit has had no major difficulty, and for a period of a year the unit, in so far as the boiler is concerned, has been in a condition to operate at full design values of capacity, pressure, and temperatures, and has actually operated at these values for a period of over 8 months.

The faith of the authors in the soundness of natural circulation for this design pressure was completely substantiated at the very start by measurement of circulation as the boiler was first brought to operating pressure. As a matter of fact, circulation tests showed circulation values which exceeded calculated performance. With 940 F steam temperature and 900 F reheat temperature, 43 per cent of the heat value in Btu absorbed per pound of steam at the maximum design load of 550,000 lb per hr is used for superheat and reheat; whereas, with 1300 psi and 950 F, only 27 per cent is used for superheat; and with 400 psi and 700 F, only 14 per cent is used. Because of this, it was necessary to install superheater and reheater surface in zones of higher gas temperature than usual.

Adjustments and Changes

In the original boiler, the fur-

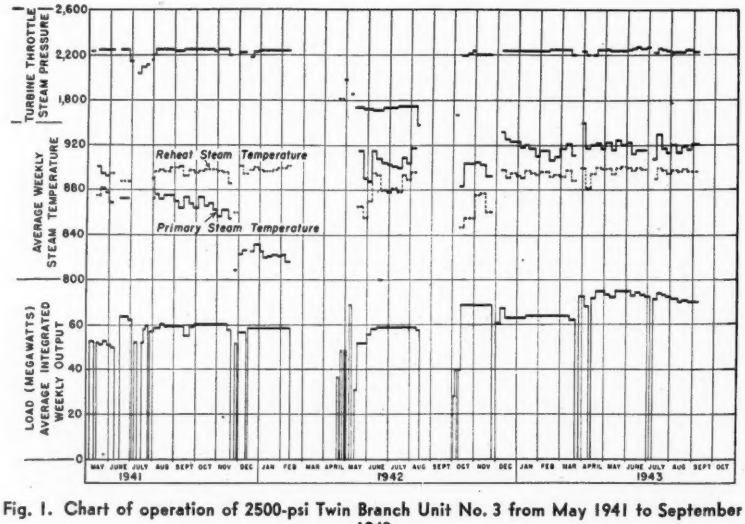


Fig. 1. Chart of operation of 2500-psi Twin Branch Unit No. 3 from May 1941 to September 1943

*Abstract of one of three related papers presented before the Annual Meeting of the ASME Nov. 29-Dec. 3, 1943, at New York City. The other two, Natural Circulation Test Results in the 2500-psi Twin Branch Boiler, by W. H. Rowand and T. B. Allardice and Distribution of Heat Absorption and Factors Affecting Performance of Twin Branch 2500-psi Boiler, by F. G. Ely and L. B. Schueler, will be abstracted in future issues.

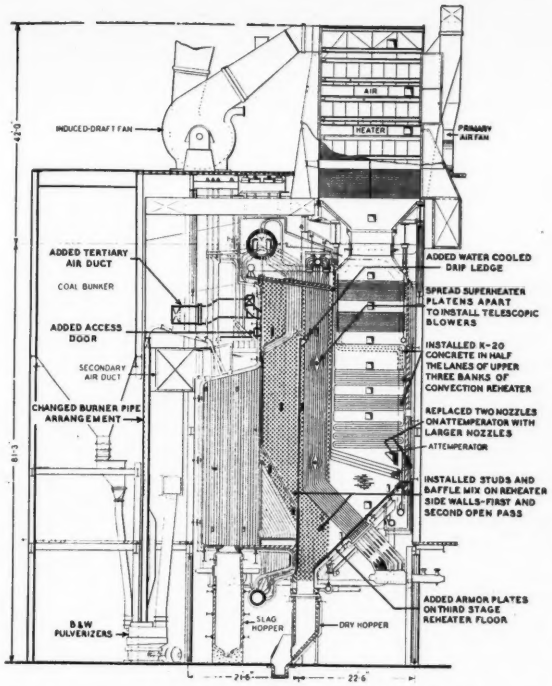

INDUCED-DRAFT FAN
AIR HEATER
PRIMARY AIR FAN
ADDED TERTIARY AIR DUCT
COAL BUNKER
ADDED ACCESS DOOR
SECONDARY AIR DUCT
CHANGED BURNER PIPE ARRANGEMENT
ADDED WATER COOLED DRIP LEDGE
SPREAD SUPERHEATER PLATENS APART TO INSTALL TELESCOPIC BLOWERS
INSTALLED K-20 CONCRETE IN HALF THE LANES OF UPPER THREE BANKS OF CONVECTION REHEATER
REPLACED TWO NOZZLES ON ATTEMPERATOR WITH LARGER NOZZLES
ATTEMPERATOR
INSTALLED STUDS AND BAFFLE MIX ON REHEATER SIDE WALLS-FIRST AND SECOND OPEN PASS
ADDED ARMOR PLATES ON THIRD STAGE REHEATER FLOOR
B&W PULVERIZERS
SLAG HOPPER
DRY HOPPER

Fig. 2. Arrangement of 2500-psi boiler as operated from June 15, 1941, to February 13, 1942

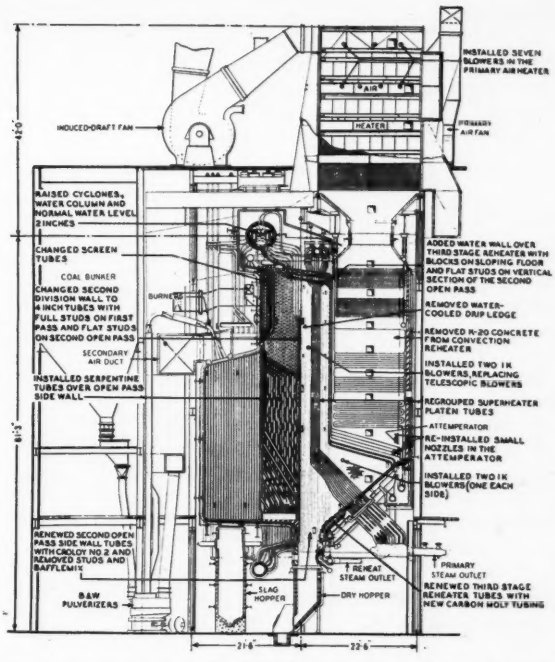

INSTALLED SEVEN BLOWERS IN THE PRIMARY AIR HEATER
INDUCED-DRAFT FAN
AIR HEATER
PRIMARY AIR FAN
RAISED CYCLONES, WATER COLUMN AND NORMAL WATER LEVEL 2 INCHES
CHANGED SCREEN TUBES
COAL BUNKER
CHANGED SECOND DIVISION WALL TO 4 INCH TUBES WITH FULL STUDS ON FIRST PASS AND FLAT STUDS ON SECOND OPEN PASS
SECONDARY AIR DUCT
INSTALLED SERPENTINE TUBES OVER OPEN PASS SIDE WALL
RENEWED SECOND OPEN PASS SIDE WALL TUBES WITH CROLOY NO 2 AND REMOVED STUDS AND BAFFLEMIX
B&W PULVERIZERS
SLAG HOPPER
DRY HOPPER
REHEAT STEAM OUTLET
PRIMARY STEAM OUTLET
ADDED WATER WALL OVER THIRD STAGE REHEATER WITH BLOCKS ON SLOPING FLOOR AND FLAT STUDS ON VERTICAL SECTION OF THE SECOND OPEN PASS
REMOVED WATER-COOLED DRIP LEDGE
REMOVED K-20 CONCRETE FROM CONVECTION REHEATER
INSTALLED TWO IK BLOWERS, REPLACING TELESCOPIC BLOWERS
REGROUPED SUPERHEATER PLATEN TUBES
ATTEMPERATOR
RE-INSTALLED SMALL NOZZLES IN THE ATTEMPERATOR
INSTALLED TWO IK BLOWERS (ONE EACH SIDE)
RENEWED THIRD STAGE REHEATER TUBES WITH NEW CARBON MOLY TUBING

Fig. 3. Arrangement of 2500-psi boiler as operated from April 30 to August 14, 1942

nace front wall and the first and second division walls were 3¼-in. partial-stud tubes on 6-in. centers. The furnace side walls were 4-in. partial-stud tubes on 6-in. centers. These walls comprise the entire steam-generating surface. The partial-stud tubes have a bare face to the furnace. The side walls of the first open pass and the side walls and rear wall of the second open pass were reheater surface as was 25 per cent of the width of the convection pass. Seventy-five per cent of the width of the convection pass plus seven groups of platen tubes across the width of the second open pass were superheating surface. A spray-type attemperator located in the connecting pipe between the convection superheater and the platens provided superheat control and dampers at the economizer outlet provided reheat control.

The first column in Table 1 shows the heat absorption during the initial period of operation. At 52,000-kw output, the superheat- and reheat-surface absorption rates exceeded the design expectations. To keep the final steam temperatures down to design levels, it was necessary to employ more than double the calculated full-load attemperation. A change in the surface distribution was, therefore, indicated. However, to obtain operating data and experience at high ratings with the high-ash Indiana coal, to aid in deciding upon the necessary permanent corrective steps and to permit practical operation until the material could be fabricated, it was decided to make relatively quick temporary alterations.

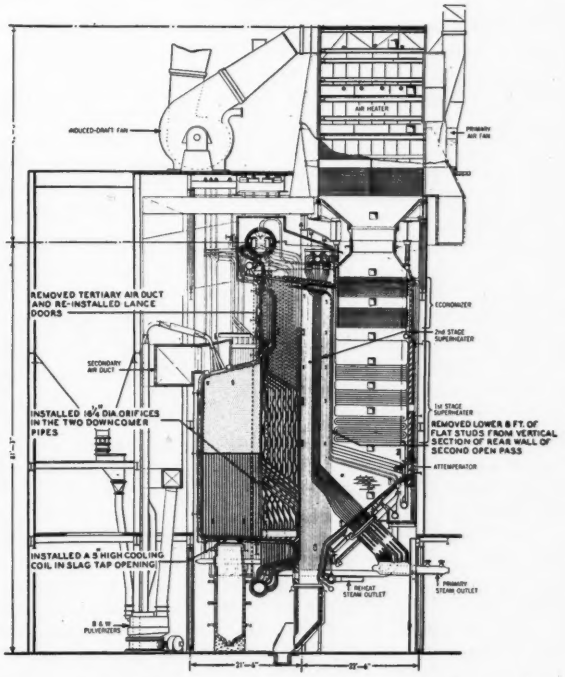

INDUCED-DRAFT FAN
AIR HEATER
PRIMARY AIR FAN
REMOVED TERTIARY AIR DUCT AND RE-INSTALLED LANCE DOORS
ECONOMIZER
2nd STAGE SUPERHEATER
SECONDARY AIR DUCT
1st STAGE SUPERHEATER
INSTALLED 16¼ DIA ORIFICES IN THE TWO DOWNCOMER PIPES
REMOVED LOWER 8 FT. OF FLAT STUDS FROM VERTICAL SECTION OF REAR WALL OF SECOND OPEN PASS
ATTEMPERATOR
INSTALLED A 5 HIGH COOLING COIL IN SLAG TAP OPENING
REHEAT STEAM OUTLET
PRIMARY STEAM OUTLET
B&W PULVERIZERS

Fig. 4. Arrangement of 2500-psi boiler as operated since December 1, 1942. From October 1 to November 24, 1942, boiler had operated with following changes made subsequent to those of Fig. 3 and prior to those of Fig. 4: changed first division wall to 4-in. full studded tubes and lowered opening of screen; installed stud plates and covered with P. C. O. upper 15 ft of primary furnace side and front wall; added Y fittings in second division wall and installed 14 additional tubes in first division wall

Figure 2 shows these temporary alterations, completed by June 15, 1941. With these changes made, it was possible to operate the unit up to maximum rating by overattemperation and to maintain the excess air on the low side; and this afforded the opportunity to obtain test data and operating experience at high

loads. The unit output, however, averaged about 60,000 kw. Continuous output at higher loads was impractical because of excessive slag accumulation in the second open pass, and the flame cutting through between some of the tubes of the second division wall due to low excess-air conditions.

During this operating period, total circulating flow was 5,100,000 lb per hr rather than 3,600,000 lb per hr expected. Due to this additional circulation and the endwise flow of the water in the drum, some water-level instability was encountered at low gage-glass levels and occasional "shots" of carryover occurred because of unbalanced water levels between the two ends of the drum. Hence, it was decided to raise the gage glasses, cyclone separators, and normal water level 2 in.

Figure 3 shows the alterations made to the unit during a 2-month outage beginning in February 1942.

Shortly after the unit was returned to service on April 20, 1942, two tubes in the first division wall failed on two occasions when the load was raised to 480,000 lb per hr and the seventh and eighth burners were placed in service.

The first failure was in the form of a crack in the tube, the leakage being such that an orderly unloading of the unit was permissible. The second failure, however, was due to a sudden opening up of the tube resulting in an instantaneous shutdown of the boiler. The automatic protective devices provided, coupled with the thorough training program to which the operating staff had been schooled, and the detailed manner in which preparations were made for such an eventuality, made possible a perfect handling of the situation. Turbines and all auxiliaries were shut down in proper sequence and the boiler was bottled up so that the drum was not subjected to any undue thermal stress. No ill effects of any kind were encountered subsequent to the repair of the tube and the restarting of the boiler.

These failures were caused by thermally induced stresses well above the yield point, produced by extremely high absorption rates across the tube wall approximately ½ in. thick. For a permanent solution of this trouble, these lanes should be closed off, and the wall again made solid by additional tubes. To permit the unit to stay on the line until permanent repairs could be made, these tubes were covered with stud plates and chrome ore and the load was limited to six-burner operation. Also the unit was operated temporarily at approximately 1750 psi, to take advantage of reduced-pressure stress.

Table 1—Typical Absorption Distribution, Twin Branch 2500-psi unit
(Figure numbers in table are those given in original paper. In this article, original Figs. 2 and 3 are combined as Fig. 2, original Fig. 4 is Fig. 3 here. Fig. 7 is omitted, original Fig. 8 is Fig. 4 here)

OPERATING PERIOD	1				2		3	
ARRANGEMENT SHOWN IN	FIG. 2	FIG. 3			FIG. 4	FIG. 7	FIG. 8	
TYPICAL DATA WITHIN PERIOD	MAY 1941	JULY 1941	AUG. 1941	JAN 1942	JULY 1942	NOV 1942	DEC 1942	MAY 1943
APPROXIMATE OUTPUT - KW	52,000	64,000	60,000	55,000	59,000	62,000	67,000	76,000
STEAM FLOW TO TURBINE - LB./HR	375,000	490,000	440,000	401,000	438,000	453,000	478,000	561,000
WATER FLOW TO ATTEMPERATOR - LB./HR.	38,000	60,000	40,000	41,000	0	0	0	0
OPERATING PRESSURE - LB./SQ. IN.	2275	2300	2300	2260	1875	2230	2280	2315
STEAM TEMP. AT SUPERHEATER OUTLET - F	936	880	893	832	903	913	939	928
STEAM TEMP. TO REHEATER - F	525	505	501	458	537	523	544	550
STEAM TEMP. FROM REHEATER - F	900	880	905	903	884	887	896	900
STEAM TEMP. RISE IN SUPERHEATER - F								
FIRST STAGE	212	236	211	187	150	162	193	180
ATTEMPERATOR	-125	-151	-113	-139	0	0	0	0
SECOND STAGE	194	141	141	130	128	101	91	91
TOTAL	281	236	239	178	278	263	284	271
STEAM TEMP. RISE IN REHEATER - F								
FIRST STAGE	100	76	99	137	153	187	192	131
SECOND STAGE	61	95	77	97	77	53	44	90
THIRD STAGE	214	204	228	211	117	124	116	129
TOTAL	375	375	404	445	347	364	352	350

The alterations indicated in Fig. 3 were quite successful in reducing the superheat and reheat to the design levels as shown in operating period 2 in Table 1. With proper excess-air conditions the superheat and reheat were somewhat on the low side, and slag troubles were eliminated.

Further Alterations Made

On the other hand, the rating of the unit was definitely restricted. Hence, when the first opportunity, determined by system capacity and load conditions, presented itself after the material needed for the next change had been fabricated, the unit was shut down and the changes which started with the shut down of August 14 were initiated. The upper 15 ft of the furnace side walls and front wall were covered with stud plates and chrome ore to eliminate the temperature peaks caused by shedding slag. The first division wall was changed to 4-in. full-studded tubes on 6-in. centers, and the wall made solid by bringing 14 tubes over from the second division wall. The screen opening from the furnace was also lowered 7 ft, in order to provide longer gas travel and to give a wider range for free-running slag.

These changes eliminated the high localized absorption rates and permitted slag-tapping at a load as low as 300,000 lb per hr. The increased steam-generating circuits increased the circulation rate to 5,500,000 lb per hr, which produced some water-level instability at low levels, at ratings above 500,000 lb of steam per hr and the water level would become as much as 3 in. to 4 in. different between the two ends of the drum with unbalanced firing conditions.

As shown in Fig. 4, this trouble was corrected during Thanksgiving, 1942, by installing a 16¼-in.-diam orifice in each of the two 28-in. downcomers, which reduced the circulation to 5,000,000 lb per hr at full load and increased the resistance in the downcomers sufficiently to bring the water level at the two ends of the drum within ½ in. of each other, regardless of firing conditions. There has not been a case of water-level instability or shots of carryover since then. At the same time, a 5-in.-high cooling coil was installed around the slag-tap hole to retain the slag level over the floor to about 6 in. at the hole. Also, the lower 8 ft of the flat studs were removed from the waterwall at the rear of the second open pass. These changes resulted in the proper balance of superheat and reheat, as shown by the data under operating period 3 of Table 1.

Feedwater Chemistry

The problems in the boiler-feedwater chemistry anticipated by some did not materialize. The feedwater treatment and boiler-water conditions that are maintained are comparable with our 1500-psi boilers. In the matter of

Table 2—Efficiency tests of 2500-psi boiler, with expected performance for comparison

Date Time of day	Expected performance	May 12, 1943 8 a.m.-5 p.m.	May 14, 1943 8 a.m.-5 p.m.
Coal fired per hr, lb	71000	64921	65013
Steam flow to turbine, lb per hr	550000	556250	560440
Steam flow through reheater, lb per hr	440000	466520	470040
Heat value of coal as fired, Btu	10000	11126	11248
Efficiency of boiler unit, per cent	85.63	86.81	87.04
Boiler drum pressure, psig	2440	2334	2343
Superheated-steam-line pressure, psig	2335	2261	2271
Reheater-inlet pressure, psig	420	424	428
Reheater - outlet pressure, psig	376	400	405
Final primary-steam temperature, F	940	930	928
Reheat-inlet steam temperature, F	545	554	550
Final reheat - outlet steam temperature, F	900	893	900
Economizer-inlet feed temperature, F	487	476	473
(HVT) gas temperature entering convection section F	2020	1870	1869
Average gas temperature entering air heater, F	690	712	712
Average gas temperature leaving air heater, F	347	407	396
Average air temperature entering forced-draft fan, F	80	101	95
Total air entering first open pass, per cent	....	115.0	114.9
Total air leaving air heater, per cent	133	126.2	126.9
Total draft loss, in. H_2O	11.3	11.0	11.4
Total secondary-air resistance, in. H_2O	9.3	8.1	8.7

Table 3—Operating data, entire Twin Branch No. 3, 2500-psi installation, covering period from 4:00 a. m. March 26 to Midnight, August 31, 1943

Total hours in period	3,812
Total hours operated	3,686.88
Total generation, kwhr	267,997,000
Generation per hour, kw	72,689
Auxiliary power, kwhr	16,744,611
Total output, kwhr	251,306,389
Total fuel consumed, lb	233,941,000
Heat value of coal as fired, Btu	10,778
Output, Btu per kwhr	10,035
Thermal efficiency, per cent	34.0
Capacity factor, per cent	91.9
Output factor, per cent	95.0
Availability of the unit, per cent	96.7

Outages:	No. hours off
Friday, April 9, unit No. 3 was removed from service for leak check test on low-pressure condenser, and acid washing high-pressure and cross-over heaters feedwater side, and inspection of induced-draft fans. Unit was returned to service 10 p.m. Sunday, April 11, 1943	53.04
Unit No. 3 out of service 72.08 hr as per schedule for inspection of boiler, changes to electrical connections to accommodate unit No. 4, and general inspection of unit and auxiliaries during period July 2, to July 6, 1943	72.08
Total time off during this period	125.12

Jack-bolt arrangement was provided on bearings 1 and 2 during shutdown from 8:47 p.m., March 19, to 4 a.m., March 26, 1943. This change permitted full-load operation of unit.

steam purity, the conductivity of steam from the boiler averages 0.8 micromho. This is equivalent to solids carryover of about 0.5 ppm. Tests on evaporated-steam samples substantiate this value. A slow building up of stage pressures takes place on the high-pressure turbine. Whenever these pressures approach the established limitations, the condition is corrected by dropping the primary-steam temperature by attemperation for a period of several hours.

Turbine

Those responsible for the design of this project and the turbine design had by that time so thoroughly integrated the experience encountered on the Logan and the Windsor turbines as to feel confident that a first-stage bucket having a length of only 0.75 in. and utilizing construction similar to that employed in the rebuilt first stages of the Logan and Windsor turbines would give no difficulties of any kind. Experience has fully borne this out.

Vibration of the turbine rotor in its bearings appeared in the initial operating period of the unit and was apparently corrected by altering the oil flow to the bearings. When the turbine could be run at its full-load rating, there was a recurrent vibration of the shaft within the bearings. The difficulty was diagnosed as due to oil whip and that was caused by inadequate loading of the upper halves of the bearings. It was ultimately corrected by the addition of jack bolts. These jack bolts artificially load the halves of the bearings at all times, and no further trouble has since been experienced from bearing vibration.

Electrical

Electrical storms on the 27,600-v system being supplied from Twin Branch have dropped auxiliaries off the line on several occasions but without any serious consequence to the unit. This was due primarily to the impedance relationships of the various windings of the main power-transformer bank of this unit. This is a 4-winding bank and one of the windings supplies a 2300-v auxiliary bus. The difficulty has been taken care of for the present by feeding the 2300-v auxiliary bus from another transformer taking its supply from the 27,600 bus. The final solution has been worked out in connection with unit No. 4 at Twin Branch, now in process of completion.

Boiler Feed Pumps

Operation of the high-pressure boiler feed pumps has reached a point of reliability comparing favorably with that of pumps in plants of much lower pressure. However, a number of corrections had to be carried out before this availability was achieved.

Vibration of the outboard and discharge end of the pump shaft and bearing caused disturbances of packing, excessive shaft-sleeve wear, scoring of bearings, and wear of main oil gear drive. This was eliminated by adjustments to balancing-drum clearances, better shaft alignment, and rotor balance.

In the early stages of operation, packing life was short and shaft-sleeve wear excessive. This difficulty was entirely cured and packing life has been greatly extended by dropping the labyrinth leak-off pressure to a value between 90 and 110 psi. Under these conditions packing life is now just as satisfactory as with 1500-psi pressure pumps.

A certain amount of erosion, as a result of high pressure, was experienced due to leakage past the separating diaphragms between stages. This has been minimized by the use of stainless steel on the sealing surfaces. Excessive wear of shaft sleeves, balancing drums, and labyrinth parts has been materially reduced by substitution of parts made from more suitable alloy material. There has been no loss of plant capacity due to failure of a boiler feed pump.

Operation and Performance

Operating and maintenance problems resulting from operation at high pressure have been relatively few, in fact less than on any of the 1500-psi plants of most recent construction on the American Gas & Electric Company systems. There has been no difficulty with any of the high-pressure piping or valves. Some slight leakage is being experi-

(*Continued on page* 132)

Tests On Coal-in-Oil Fuels*

By
J. F. Barkley
U. S. Bureau of Mines
A. B. Hersberger
The Atlanta Refining Co.
L. R. Burdick
U. S. Bureau of Mines

No particular difficulty in devising equipment or operating routine for efficient use of coal suspensions in fuel oil need be experienced. A sufficiently stable suspension of coal in oil for practical purposes can be prepared by dispersing 40 per cent coal by weight ground from 98 to 99 per cent through a 230-mesh screen in heavy fuel oil. Careful control of storage and handling temperatures is required for most successful operation. Combustion efficiency of coal-in-oil fuels is likely to be slightly less than that of fuel oil alone

THIS REPORT covers laboratory studies on the stability of coal suspensions in oil, the mixing of pulverized coal and oil, and field tests on these mixtures in typical oil-burning equipment. This work was undertaken to obtain needed practicable information not found in technical literature. The work is the result of a joint effort by the Federal Bureau of Mines and The Atlantic Refining Co. of Philadelphia, Pa. The laboratory work and preparation of the fuels were done by The Atlantic Refining Co. The main series of field tests made at The Atlantic Refining Co.'s Philadelphia Plant and additional tests made at the Cambria Silk Hosiery Co. and the National Airoil Burner Co., both in Philadelphia, were conducted by the Bureau of Mines.

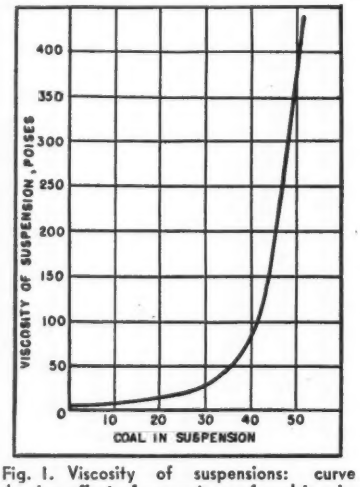


Fig. 1. Viscosity of suspensions: curve showing effect of percentage of coal in mixture on viscosity at 77 F (coal No. SC-2, minus 230 mesh; No. 6 fuel oil)

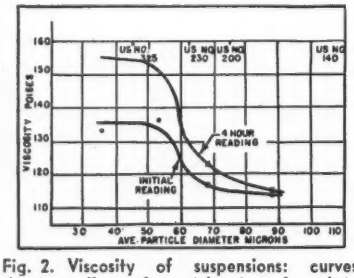


Fig. 2. Viscosity of suspensions: curves showing effect of particle size of coal in mixture on viscosity at 77 F (Coal No. SC-1, 40 per cent by weight; No. 6 fuel oil, 60 per cent by weight)

Laboratory Studies

In the laboratory, stabilities of coal-in-oil suspensions were studied by measuring the change in the center of gravity of the suspensions by means of a pendulum arrangement. This method was first used by Manning and Taylor. The results are reported as the percentage of the coal settled, based on 100 per cent settled, as determined in an alcohol-water mixture. Other methods were also used to check the results obtained in this manner.

The majority of the samples were mixed by vigorous stirring under about 10-mm vacuum. This was done to avoid including air in the samples which would eventually interfere with the pendulum readings. The coal used in most of the experimental work was screened to narrow-size ranges. The data presented in Figs. 1 to 6, inclusive, are representative of a large number of experiments. The properties of the bituminous coal and the oil used in this particular set of experiments are given in Table I. The oil was a typical refinery product containing both straight-run and cracked components.

From consideration of elementary formulas, relating settling velocities to particle size, gravity differential between the particles, and the liquid medium and its viscosity, it was evident that the best results would be obtained by using bituminous coals (low specific gravity), and oils of high specific gravity and high viscosity. It was also evident that suspensions of high coal content would be more stable than those of low content because of hindered settling.

The actual conditions for settling in concentrated suspensions are complex. Such suspensions develop rigidity for high solids content. Coal-in-oil suspensions have been shown to develop this rigidity in the neighborhood of 38 volume per cent of coal.

A number of experiments were run to determine the effect of coal concentration on the viscosity of the coal-in-oil suspension. For finely divided coals in heavy fuel oils, the viscosities of the suspension were found to rise markedly in the region of 40 to 50 per cent of coal by weight, such results being in general agreement with those reported by others. This rapid rise in viscosity in the range of 40 to 50 per cent of coal was found to be relatively independent of the viscosity of the oil and the temperature of the measurement. These suspensions were also found to be non-Newtonian, i.e., the viscosity varied with the rate of shear, this deviation from viscous flow resulting from the development of structure in the suspension. Figure 1 shows a typical viscosity-per cent coal curve.

The relation of the stability of the suspension to the coal concentration was determined for minus-230-mesh bituminous coal. These results are shown in Fig. 6. No worthwhile degree of stability is obtained until a coal concentration of approximately 40 per cent by weight is used.

The effect of physical properties of the oil and coal on stability of suspensions was also found to be important. Oils with either low viscosity or low specific gravity, in general, gave less stable suspensions. No marked differences in the stability of suspension of bituminous coals of slightly different properties were observed, although the range of bituminous coals studied was narrow. One experiment was run on a sample of anthracite which proved to be considerably less stable than a similar suspension containing a bituminous coal. Data illustrating these facts appear in Table II.

The coal used in the laboratory experiments was screened to a nar-

*Abstract of a paper presented at a Joint Meeting of The American Society of Mechanical Engineers and the American Institute of Mining Engineers, Fuels and Coal Divisions, Pittsburgh, Pa., Oct. 28-29, 1943, and published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

row range of sizes. From a practical point of view the effect of the maximum-size coal particles on the stability of the suspensions is important. The presence of small quantities of oversize particles was found to decrease the stability of the suspensions; data are shown in Table III.

If the criteria, from a stability and handling viewpoint, of a satisfactory coal-in-oil fuel are (1) high degree of stability at normal temperature, (2) sufficient stability at elevated temperatures to permit handling in conventional oil-burning equipment and (3) reasonable viscosity, the results of this work point toward a 40 per cent by weight suspension of minus-230-mesh bituminous coal dispersed in No. 6 fuel oil. For practical purposes, the coal-specification size could be set at 98-99 per cent passing a 230-mesh screen and the limiting oil properties at 12° to 14.8 A.P.I. gravity at 60 F, and 55-70 Furol viscosity at 122 F. The laboratory results also indicate that the coal can be dispersed in the oil by relatively simple methods.

Tests in Typical Oil-Burning Plants

To obtain information on the operating problems involved in handling and burning coal-in-oil mixtures in typical oil-burning plants, tests were made at three different plants. From the laboratory information, it was decided to experiment with fuel of about 40 per cent coal by weight. Four batches of fuel were prepared, one batch having coal of a fineness of about 88 per cent through a 230-mesh ASTM (U. S.) Standard Screen, one of about 95 per cent, and two of about 99 per cent. Coal could be ground to this fineness in present standard commercial equipment. As far as the authors know, no equipment is available at present that will, from a practical standpoint, continuously and satisfactorily produce coal of, say, the extreme fineness of minus-325 mesh. Table IV gives data on the coal and oil used in the mixtures.

As indicated by the laboratory results, it was found in the field that the mixing of the coal and oil needed for the tests did not present much difficulty.

Putting coal into oil produces a fuel having characteristics different from those of oil. The mixture used was about 10 per cent heavier in weight per unit volume than oil; it was about 4 to 8 times as viscous depending upon the temperature; it was much more abrasive; any settling out of the coal resulted in pastelike accumulations in various parts of the equipment, such as tanks, heaters and valves; the ash from the coal was set free in the furnace.

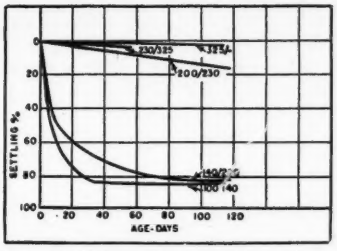


Fig. 3 Stability of suspensions: curves showing effect of particle size of coal in mixture on stability at 77 F (coal No. SC-1, 40 per cent by weight; No. 6 fuel oil, 60 per cent by weight)

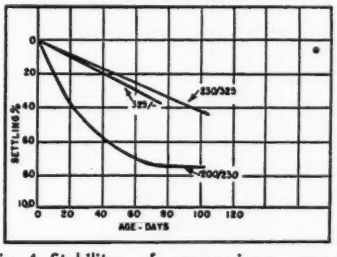


Fig. 4 Stability of suspensions: curves showing effect of particle size of coal in mixture on stability at 120 F (coal No. SC-1, 40 per cent by weight; No. 6 fuel oil, 60 per cent by weight)

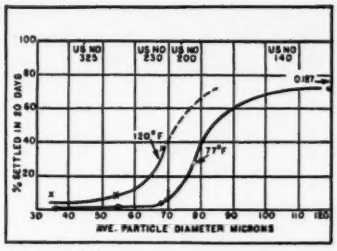


Fig. 5. Stability of suspensions: curves showing effect of particle size of coal in mixture on amount of settling in 20 days (coal No. SC-1, 40 per cent by weight; No. 6 fuel oil, 60 per cent by weight)

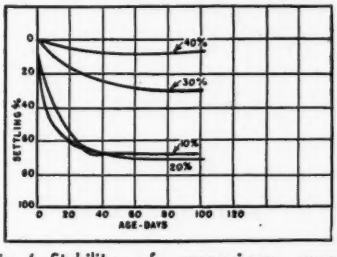


Fig. 6 Stability of suspensions: curves showing effect of percentage of coal in mixture on stability at 77 F (coal No. SC-2, minus 230 mesh; No. 6 fuel oil)

Tests at Atlantic Refining Company Boiler Plant

The first and main series of tests was made at one of the boiler plants of the Atlantic Refining Co. The boiler-plant equipment was typical of that of many oil-burning plants. The fuel was heated to about 160 to 200 F at the set and was pumped about 110 ft to the boiler. A standard Best steam-atomizing burner was used. The fuel and steam were under hand control.

The boiler was a 151-hp, longdrum, straight water tube Babcock & Wilcox boiler, 8 tubes wide and 9 tubes high. Figure 7 shows the boiler layout. Operators obtained slightly lower boiler efficiencies with the coal-in-oil fuels than with the oil; about 79.5 to 80.5 per cent was obtained with the coal-in-oil fuels against 81.2 per cent with the oil; the difference is small enough to be within test errors. There was a small loss of unburned combustible in the fly ash for the coal-in-oil fuels that was measurable.

No difficulties arose in burning the coal-in-oil fuels in the furnace with the steam-atomizing burner used. The CO_2 content of the products of combustion could be carried as chosen up to about 16 per cent with no CO. During operation no difficulties were experienced in the production of smoke; smoke could be controlled the same as with oil. However, in starting up a cold furnace with a coal-in-oil fuel, considerable smoke was produced. The boiler was operated at about rating during most of the testing, this load fitting best into the plant steam requirements from this boiler house. However, ratings from about 40 per cent to over 200 per cent were carried for hours without difficulty.

About two-thirds more atomizing steam was required for the coal-in-oil fuels than for the oil. Both saturated steam and superheated steam were tried. Essentially the same amount of each was required to produce the same combustion results, as far as could be measured. It was found, however, that superheated steam gave a little less difficulty from pulsations and blowing of flame from the burner when higher amounts of steam per pound of fuel were used.

Troubles from the ash of the coal in the furnace were less than had been anticipated. There was no dripping or slagging. The fly ash on the tubes was cleaned without difficulty every 8 hr during the test by the boiler soot blowers. About 45 per cent of the ash in the fuel accumulated in the furnace and breeching of the boiler.

It was found that with Batch No. 1, for which coal had been ground to a fineness of about 88 per cent through a 230-mesh screen,

Table I. Physical Properties of Coals and Oil Used in Laboratory Experimental Stability Studies

	Coal	
	No. SC-1	No. SC-2
Specific gravity at 60 F	1.29	1.34
Volatile, per cent	33.1	22.1
Ash, per cent	3.5	4.5
Moisture, per cent	0.7	0.4
Fixed carbon, per cent	62.7	73.4
Sulphur, per cent	0.78	1.19

No. 6 Fuel Oil	
A.P.I. gravity at 60 F	14.6
Viscosity at 122 F	56 Furol
Viscosity at 210 F	86 Saybolt

Table II. Effect of Physical Properties of Coal and Oil on Stability of Suspension*

Coal			Oil		
Type	Specific gravity at 60 F	Mesh	A.P.I. gravity at 60 F	Furol viscosity at 122 F	Stability 10 per cent settled at 120 F, days
Bituminous	1.29	230/325	14.6	56	23
Bituminous	1.29	230/325	...	29	3
Anthracite	1.56	minus 230	12.7	64	5
Bituminous	1.32	99 per cent minus 230	14.4	66	12
Bituminous	1.32	99 per cent minus 230	17.5	89	6

*Coal by weight, 40 per cent.

Table III. Effect of Oversize Particles on Stability of 40 Per Cent Suspension of Coal in Oil by Weight*

Size of oversize coal	Oversize coal, per cent (based on coal)	Stability 10 per cent settled at 120 F, days
Blank—230/325-mesh bituminous coal in No. 6 fuel oil	..	23
100/140	5	14
6/100	5	5

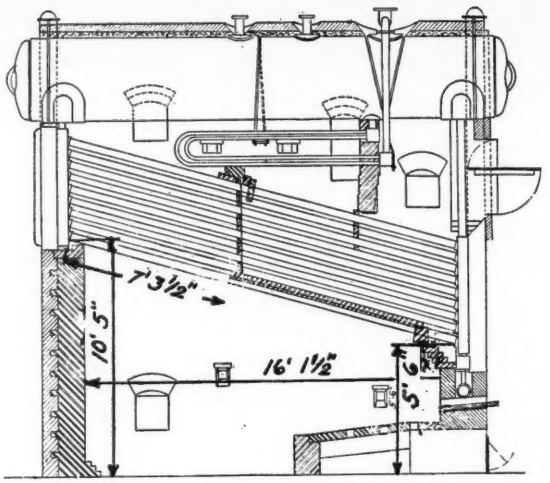


Fig. 7. General layout of boiler and furnace at The Atlantic Refining Co. plant which was tested with coal-in-oil fuels

there was considerable sludge accumulation at the bottom of the tank after about 7 days. The average temperature maintained in the tank was 81 F; no movement was given the fuel. With Batch No. 2, for which coal had been ground to 95 per cent through a 230-mesh screen, only a small amount of sludge had accumulated at the end of 5 days. The average temperature in this case was 85 F. With Batch No. 3, for which coal had been ground to 99 per cent through a 230-mesh screen, no discernible settling occurred after 9 days with the temperature in the tank at about 82 F. When the temperature was raised to 120 F, however, sludge accumulation was definitely discernible at the end of a few days. About 1500 gal of Batch No. 4, for which coal had been ground to 99 per cent through a 230-mesh screen, was loaded in a typical delivery tank truck at about 115 F. The truck was then driven on the highway for about 9 hr covering about 150 miles; it was then allowed to stand for 32 hr. No settling occurred. The fuel was allowed to stay in the standing truck about 8 weeks. No settling was found at the end of this period. These field findings check with the laboratory findings.

No settling or clogging was experienced in the pipe lines from tank to pump to burner, although the lines were relatively long and the fuel was at elevated temperatures.

There was appreciable accumulation of coal-oil paste in the heater when both Batch No. 1 and Batch No. 2 were used. It was unnecessary, however, to clean the heater during either test run. With the 88 per cent coal, there was an accumulation of 113 lb of paste after about 7 days; with the 95 per cent coal, 84 lb of paste after about 6 days. With the 99 per cent coal, the accumulation after about 9 days was practically negligible, being so slight as not to warrant cleaning the heater.

There was some clogging in the meters and screens with all of the coal-in-oil fuels. Occasionally

(*Continued on page* 132)

Table IV. Data on coal, oil, and resulting coal-in-oil fuels

Batch No.	1	2	3	4
Coal, approximate percentage by weight in mixture	39.4	39.7	39.5	40.7
Proximate analysis:				
Moisture, per cent	1.7	1.5	1.3	1.4
Volatile, dry basis, per cent	35.5	35.9	37.0	36.6
Fixed carbon, dry basis, per cent	58.4	56.3	58.6	58.9
Ash, dry basis, per cent	6.1	7.8	4.4	4.5
Sulphur, dry basis, per cent	0.8	0.8	0.7	0.8
Btu, dry basis	14310	13990	14540	14520
Ash, initial deformation, deg F	2300	2230	2540	2570
Ash, softening temperature, deg F	2410	2300	2660	2690
Ash, fluid temperature, deg F	2720	2770	2910	2850
Ultimate analysis, dry basis:				
Carbon, per cent	79.9	78.0	81.5	81.1
Hydrogen, per cent	5.3	5.1	5.4	5.4
Oxygen, per cent	6.3	6.9	6.5	6.7
Nitrogen, per cent	1.6	1.4	1.5	1.5
Sulphur, per cent	0.8	0.8	0.7	0.8
Ash, per cent	6.1	7.8	4.4	4.5
Fineness, approximate, U. S. Std sieves:				
Retained on No. 100 sieve, per cent	0.3	0.02	0	0
Retained on No. 200 sieve, passing No. 100 sieve, per cent	6.5	2.68	0.3	0.2
Retained on No. 230 sieve, passing No. 200 sieve, per cent	5.7	2.8	0.3	0.2
Retained on No. 325 sieve, passing No. 230 sieve, per cent	12.1	8.4	6.4	6.4
Passing No. 325 sieve, per cent	75.4	86.1	93.0	93.2
Total, per cent	100.0	100.00	100.0	100.0

Batch No.	1	2	3	4
Oil, approximate percentage by weight in mixture	60.6	60.3	60.5	59.3
Ultimate analysis:				
Carbon, per cent	86.6	86.4	86.9	87.0
Hydrogen, per cent	10.6	10.6	10.7	10.8
Oxygen, per cent	1.0	0.9	0.5	0.4
Nitrogen, per cent	0.2	0.2	0.2	0.3
Sulphur, per cent	1.5	1.8	1.6	1.2
Ash, per cent	0.1	0.1	0 1	0 3
Btu	18320	18290	18440	18360
Specific gravity	0.980	0.980	0.979	0.977
Water content, per cent	0.20	0.18	Trace	0 2
Sediment by extraction, per cent	0.60	0.12	0 21	2.3
Pour point, deg F	30	40	35	50
Flash point,[a] deg F	270	265	275	275
Aniline point	Too dark	Too dark	Too dark	Too dark
Viscosity:				
Saybolt Furol at 70 F, sec	585.4	760.5	580.2	1119.0
Saybolt Furol at 100 F, sec	128.7	154.3	121.1	189.3
Saybolt Furol at 130 F, sec	46.0	51.9	44.7	56.7
Saybolt Universal at 170 F, sec	165.2 (17)	173.5 (17)	151.4 (15)	189.7 (19)
Saybolt Universal at 210 F, sec	82.6 (8)	88.3 (9)	81.3 (8)	93.1 (9)
Coal-in-oil:				
Viscosity				
Saybolt Furol at 70 F, sec	3368	5854		7181
Saybolt Furol at 100 F, sec	642	1015		867
Saybolt Furol at 130 F, sec	211	343		273
Saybolt Universal at 170 F, sec	734 (73)	1074 (107)		934 (93)
Saybolt Universal at 210 F, sec	327 (33)	477 (48)		426 (43)
Pour point, deg F				60

[a] Cleveland open cup.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Who's Who in the Practical Engineer Section

In the December issue we presented a very interesting article on the use of the indicator diagram by Denard Lee Gusler. In this issue we present another article by the same author, this time on a post-war power plant for the furniture industry. And, since we expect to publish other articles by Mr. Gusler, readers might like to know something about this promising young man.

Quoting from a letter, he says: "I finished high school and joined the Marine Corps when I was eighteen. While in the Marines I did considerable clerical work, the last nine months being extremely fortunate because I was a purchasing clerk in the office of the Marine Supply Division at San Francisco. During these nine months I completed one semester in the school of accountancy and commercial law at the Golden Gate College. (Night school.) After leaving the Marines I was employed by the Bassett Furniture Co. at Bassett, Va., as electrician and mechanic where my father was Chief Engineer. This job offered the most interesting, educational and practical experiences I ever expect to enjoy but the pay was small and so, after fifteen months I gave it up.

"Then I worked for one year as water tender in the Power House of the American Viscose Corporation plant at Front Royal, Va. From Front Royal I journeyed to Morgantown and went into the power plant of the E. I. DuPont de Nemours and Co., one month as condenser operator, five months as turbine operator and eight months as boiler operator, which brings me up to the present. During the past three years I have completed the ICS course in Steam Engineering and am 75 per cent through the ICS course in Mechanical Engineering. I have also completed over 1000 hr of drawing. This work consists of about 40 large prints of power house machinery and steam flows, etc. In addition I have studied numerous textbooks and bulletins from manufacturers.

"My ambition is to be a design and consulting engineer. This probably sounds funny for a person of my modest beginnings. I fully realize the limitations imposed when a person does not have a college degree but I do not accept these limitations and I hope that my varied practical experience and limited technical knowledge acquired through home study will earn me the title of at least a practical power plant engineer.

"While I have had opportunities recently to go into technical work, I plan to continue as I am for a while. I know that the practical experience I am acquiring will be priceless in the future."

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

How Do You Read— Or Do You?

How do you read engineering journals and magazines? Do you just subscribe to them and stack them up in a corner of your office? Are you a hoarder? Do you think articles too long or too short? What do you like in the way of articles?

A CHIEF ENGINEER of a medium size power plant recently informed us that he would like to get hold of a work schedule that would fit the needs of his plant. This man is a long time subscriber to Power Plant Engineering and his request was of particular interest because, as those who read these pages regularly may recall, during the past year or two we have published a considerable amount of information on work schedules of various kinds.

Quite naturally, we assumed that for one reason or another, this engineer had not seen these articles on work schedules so we called his attention to them, implying at the same time that they contained all the information he needed.

Much to our surprise, however, he knew all about these articles; he had gone over all of them very carefully he said but none of them applied to the conditions existing at his plant. He wanted a schedule that would fit his own plant. It never occurred to him that he could develop his own work schedule from the patterns set forth by the ones that had been published.

Strangely enough, this man is by no means an exception. He belongs to a class of people who have never learned or developed the process of reflective thinking; of beginning with a set of fundamental principles and proceeding by logical steps to work out the solution of a problem. From many requests that we receive it is quite evident that this type of mind is not as uncommon among engineers as one might expect.

There are, of course, many types of readers of a magazine such as this and in our years of contact with them we have been able to classify them quite accurately. For example, there is the type of subscriber who doesn't even bother to open the magazine. His type constitutes only a small class but a distinct class, nevertheless. Ask him why they are lying around unopened and usually he will inform you that he hasn't time to read them and that anyway there is little or no information in them of any use. The implication is, what can anybody tell *him* about running a plant?

If we were not perfectly familiar with this type of person we might take a report such as this to heart; we might wonder whether we were putting out the right kind of a magazine, whether this man might not be correct in his judgment of the paper. But we know from experience that this man, though he is representative of a certain small class, is not representative of even a small bulk of our readers and that no matter what we put in the paper, he still would not read it. He is not the reading type.

In his own way he is probably a good, practical, type of engineer, possessed of a fair amount of common sense and a good knowledge of mechanical equipment. The chances are, he has come up by what he terms the hard way, but most of his success is due to his aggressive personality. While he

He was having exciter trouble

tolerates technical magazines he cannot afford to appear to depend upon them for information.

Only a small percentage of readers read any large portion of any issue, first, because they do not have time; secondly, because they are interested only in specific types of articles and information. As a rule, engineers read only what they want to read; they are not easily tricked into reading by the use of clever or trick titles or by typographical devices of various sorts. If they are stopped by such means, they soon discover that they have been tricked and it leaves them with a bad taste. They are annoyed by such tactics.

We have studied the habits and the needs of operating engineers with regard to reading for many years. In most cases, we find that engineers—operating engineers in particular, want information they can use directly. Even our friend mentioned above, despite his assertion that technical journals cannot help him will stop to read an article that gives him specific directions for curing some particular kind of trouble that may have been bothering him.

The trouble with this type of person, as already pointed out, is that they are usually unable to take general or basic information and apply it to their specific problems. It is one thing to follow exact instructions for winding, say, a 36 slot, 30 coil motor armature but it is quite another matter to develop such a winding from a general article discussing the principles of armature design.

Another type of reader is the hoarder type who does not read very much but saves it for future use. This type is very prevalent both among operating and designing engineers. They thumb through an issue and whenever they run across a chart or a tabulation or an article that appears as though it may be of value, they tear it out and put it away—file it as they like to call it. Usually such things are successfully lost so that it really does not matter whether the information is good or bad, it has served its purpose. Ask these men what they think of a certain article, they will tell you "that sure was swell stuff—just what I have been looking for, for a long time. I've clipped it." But they will never read it.

Then there is the type of reader who will always tell you that the articles are too long—that they have not time to read such long articles and, why don't we publish nice short articles. This class is quite numerous and while they are probably sincere in their criticism, they really do not know what they want in the way of reading material. Usually when they really are interested in an article they will be the first to inform you that it is not complete enough. Yet, they think they want shorter articles. This inconsistent behavior merely supports our contention that an engineer, if he is interested in a particular subject, will read an article on that subject, no matter how long it is, or no matter if it is printed in small black type on red paper.

Nearly all engineers have ideas as to the type of information that should appear in technical magazines. Usually, their demands are for information on some specific problem confronting them at the moment or concerning some pet peeve. In the latter category is a demand for a piece telling architects about more practical arrangements of equipment in power plants. This is an excellent suggestion but such an article should appear in an architectural journal which is read more or less exclusively by architects. There, it would do the most good. Another man wants more "dope" on priorities, what to do to get certain materials, how to fill out forms, etc. Still another wants an article which tells how to prevent evaporation of fluid in electrolytic condensers. Why? Simply because he has a bank of such condensers mounted on his boiler room wall which obviously is not the proper place for them.

Then there is the chap with exciter

trouble. He suggests an article on how to make exciters stop hunting—these, by the way, are actual examples. Such a suggestion is good and quite in order but it so happens that when this case of trouble was finally traced to earth, it was found to be due to unequal air gaps between the armature and the field poles of the exciters. The chances are that no article dealing with the general subject would have touched upon this phase of the question. Similarly in need of help is a man with air conditioning troubles; he wants a piece on how to simplify and reduce maintenance costs of the air conditioning system. This is a quite reasonable request. On the other hand, a power superintendent of a large factory asks us to publish information on road and yard maintenance; it seems he has some 75 acres of parking lots and roadways to keep up. We wonder whether it ever occurred to him that such information might more properly be found in one of the several journals devoted to highway engineering.

And so it goes. We take all of these suggestions in good grace and through the years they guide us in our editorial work. We keep all of them in mind but, of course, we cannot satisfy everybody all the time. In general most of our contacts with readers are very pleasant and most of them seem to appreciate our efforts to bring them information. Perhaps the most outstanding example in the opposite direction, however, was the rather well-known consulting engineer who once told the writer that only one good article had ever appeared in any engineering paper. Strangely enough, he admitted that it was *not* one he had written himself.

Correct Use of Flat Leather Belting on Machine Tool Drives

By S. L. Allen,
Sales Engineer, J. E. Rhoads & Sons

TODAY, as never before, care must be taken in selecting the proper belt for machine tools. Most machine tools designed to use flat leather belting are made with either flanged or stepped cone pulleys and this type of drive has been a source of difficulty to users and belting manufacturers largely through improper application.

The principal cause of the difficulty arises because most belts will slide to one side when under heavy enough load to slip. This is an advantage in one way, for in this way the belt will slip off, saving the machine from jamming and possibly the motor from burning out or the belt from being injured. But, if used with flanges or stepped cone pulleys, the tendency is for the belt to climb on the flange or the next step of stepped cone pulley, curling its edge and being damaged beyond repair.

Belts are more "stretchy" when new than after they have been used for some time, and with longer hours, heavier loads and less experienced labor, the difficulty is accentuated at this time. However, three simple steps usually solve the problem and combine maximum production with minimum expense.

1: Before installing a belt, check alignment of pulleys, particularly idlers. Sighting along the edges of pulleys and use of a try-square, placed on the shaft where possible, usually provide sufficiently adequate check. Belts tend to ride on the "high" side of the pulley. If a belt tends to run to one side, turn it around and if it continues to run on that side, it is a sign that the pulleys are out of alignment rather than that the belt is crooked.

2: Use a firm, narrow, heavy-weight belt rather than a wider, more flexible one. Keep the belts at least 20 per cent to 25 per cent narrower than the face of the pulleys, and use as thick a belt as possible, considering the diameter of the smaller pulley and speed.

3: Because all leather belting is elastic, keep it taut, particularly when new. Just as it takes a little while to break in a pair of new shoes, so it takes a little while to break in a leather belt, and a new belt will tend to stretch most just after installation. After the belt has been used awhile, periodic inspections are usually all that are necessary.

Two or three years ago one of our customers reported not getting satisfactory results from the use of one of our belts. The belt was used to drive a lathe which faced the flanges of pipe fittings 8 in. and 10 in. in diameter. We replaced the belt with a 4-in. double, oak-tanned leather belt, installed very tight on the stepped cone pulleys. Two days later a phone call came telling us that the belt had pulled crooked and was pretty well buckled on one edge from riding the edge of the next larger pulley.

We checked the alignment and tension and both were O. K. Apparently, the belt wasn't heavy enough and it was agreed to try a heavy double oak belt. Three days later this belt had failed in the same way. The difficulty was overcome by using a medium three-ply belt.

The reason for the two failures was not clear at first until we discovered that the castings had exceptionally hard spots in them, which placed a heavy peak load on the belt, causing it to slip and stretch. The new belt did not have time to adjust itself to the pulleys before it had to pull extreme peak loads. The old belt had all of its natural stretch removed and its surface worn so that its former pulling surface was no longer in evidence. It just slipped on the peak loads, saving itself but losing production for the manufacturer.

"Look, Gus, Marshmallows"

A Post-War Power Plant For Furniture Factories

By DENARD L. GUSLER

Some time ago we published a short editorial appeal for ideas on post-war power plants. Although this appeal resulted in some comment on post-war planning in general, it resulted in little that could be called actual planning. This, at least, was the situation until we received this article by Mr. Gusler. Last month, it will be recalled, we published Mr. Gusler's splendid discussion of Indicator Cards. This month we are pleased to present an equally good article by him on his ideas for a post-war power plant for the furniture industry. This plant incorporates the use of a modern water tube boiler with a Dutch oven furnace, automatic fuel feed, induced draft and a condensing, extraction-type turbine generator as well as other desirable features. Mr. Gusler's ideas of a good plant may give others ideas as to how to improve their own plants. Further comment and discussion on this subject is invited

IN CERTAIN SECTIONS of the South there are many furniture plants that generate their own steam and electric power, using wood waste as fuel. The power house connected with these small plants is, in many instances, run down, obsolete and badly in need of modernization. The following description of one installation is generally applicable as a whole.

Sawdust from a hog and woodworking machinery in the main factory building is picked up by exhauster fans and blown to a cyclone dust separator, located over the roof of the boiler house. The sawdust is then gravity-fed through sheet metal piping to the furnaces. The flow of fuel is regulated by a system of ropes and gate valves.

The boilers are horizontal-return-tubular with small furnace volume and stationary grates. Steam from the boilers is used by a Hamilton Corliss engine and exhausted to the atmosphere against 10 psi back pressure. This engine is the prime mover for the generator supplying electric power to the factory.

A large portion of the wood waste in the form of sticks and blocks, is transported on special trucks to the boiler house and manually fed to the boilers to control the steam pressure. No flow meters or draft gages are used, so the distribution of load on the boilers and regulation of draft is a matter of judgment.

Water levels are controlled by cutting the feedwater valves on and off. Steam flow to the boiler feed pump is also manually regulated. All air for combustion is admitted through the ash pit doors.

The firemen are in continuous, frantic motion, shuttling back and forth, watching the steam gages, water levels, and chucking in gobs of fuel to poorly maintained fires. They are not able to devote proper attention to any of their many duties and can only last a few years due to labor fatique.

The riveted-joint sheet metal piping has over a period of years accumulated many leaks that allow sawdust to be carried out into the boiler room, which of course contributes to the general discomfort.

River water is pumped into a reservoir then feeds to the feedwater heater and into the boilers. This direct use of raw water causes deposits of scale and the occasional settling out of mud. The mud deposits create the danger of a blistered shell.

What Happens When the Whistle Blows

The plant operates 8 hr a day and shuts down for the noon lunch hour. At 12 o'clock, the engine operator will walk over and trip out the generator oil circuit breaker, then he tears over and neutralizes his Corliss valve gear. All relief valves on the boilers let loose with a terrific roar and continue to waste steam until the firing rate subsides sufficiently to result in a drop in pressure.

At one o'clock the firemen build up the steam pressure, the generator is synchronized, the engine instantly picks up most of its load causing a bad pressure

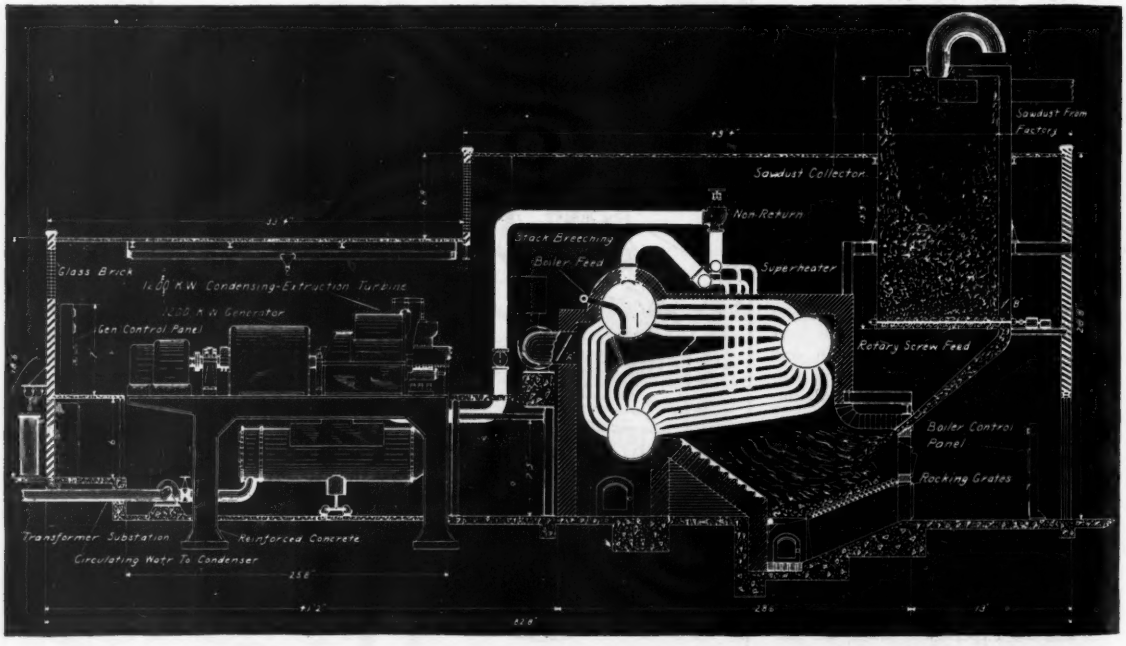


Fig. 1. Cross-section of the proposed plant. "A" Induced draft control. "B" Forced draft control

drop until sufficient fuel can be fed to bring the pressure back to normal. This requires considerable effort on the part of the firemen.

What's Wrong With the Plant

The following disadvantages render this hrt boiler installation with standard furnaces, very unsuitable for efficient combustion and steam generation.

1. Sawdust entering furnace from collector does not burn in suspension satisfactorily, because of insufficient air and inadequate flame travel.
2. Sawdust from collector piles up on grates, blocking air and causing messy fires.
3. All air for combustion must be admitted from ash pit doors, giving poor mixture of air and sawdust.
4. It is necessary to clean fires by opening fire doors and raking the fires with long hoes or tongs for extended intervals. This allows cold air to rush in, disrupting proper combustion and causing local cooling of boiler plates.
5. These old installations are usually heavily fired in a furnace volume too small for the amount of fuel being burned. This causes heavy maintenance, frequent relining of furnace and fire walls and back arch replacement.
6. When a hrt boiler is heavily fired, delayed combustion frequently results causing fires to burn in the fire tubes and the stack breeching.
7. Scale accumulations on the boiler tubes are difficult and often impossible to remove because of inaccessibility.
8. Proper regulation of fuel and air for combustion is very difficult due to lack of up-to-date draft and combustion control equipment.

Here Is What Should Be Done

The plans that follow are intended to improve this general mechanical arrangement, to increase the overall efficiency and to provide better operating conditions. Most plants such as that just described are now operating at peak capacity and complete renovation or reconstruction will be absolutely necessary after the war.

It must be emphasized that the plan presented is a post-war project. No particularly new or original ideas are in evidence. The general effort is to outline a simplified workable arrangement, the essential factors being automatic combustion control, improved furnace conditions, water treatment, and better location of equipment.

Figure 1 is a cross-section view of the proposed power house.

Air and sawdust from the factory exhausters enters the dust collectors at a high velocity, the angle of entry and centrifugal force causing the sawdust to settle out in the hoppers. Sawdust is removed from the hoppers by two screws and fed directly to the furnace. The speed of the screws is automatically controlled by the boiler steam pressure.

The ordinary type of cyclone dust separator has a vent through which air passes to the atmosphere, carrying with it, fine sawdust in suspension. Later this dust settles out on the surrounding buildings, creating an unsightly appearance and a fire hazard. The collector shown in Fig. 1 is constructed so that a large portion of the collector air passes through a special duct to the furnace and is used as the primary air for combustion.

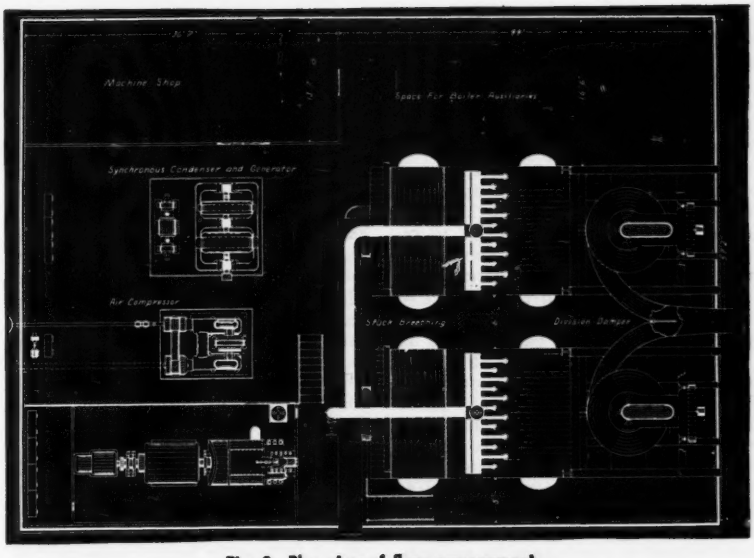


Fig. 2. Plan view of floor arrangement

The air-fuel mixture passes into a Dutch oven type of furnace. This furnace contains a very hot over-head arch and back wall. The heat radiated by these walls plus a long flame travel causes most of the sawdust to burn immediately as it enters the furnace. The finer sawdust will burn in suspension and large bits of wood will settle out on the grates. This gives a combination of suspended and stationary firing with all fuel coming directly from the collectors. All wood waste would be ground up by hogs in the main factory and blown to the dust collectors. The only fuel transported to the boiler house to be fed manually would be that which is unsuitable for hogging.

Additional air is admitted through the ash pit by cracking special louvres that are provided in the ash pit doors. This air cools the grates and furnishes the secondary air for combustion.

The fires can be cleaned by rocking the grates with manually operated levers projecting outside the furnace. Results can be observed through inspection ports in the fire doors.

A lever-operated dump plate is provided so that ash sliding down the grates can be dumped to the ash pit. Large storage capacity makes ash removal necessary only once daily.

Why a Water-Tube Boiler

The boiler is a water-tube type of the most simplified possible design. It can be assembled as a unit at the factory and shipped complete thus reducing erection costs to a bare minimum. It has five distinct advantages over fire-tube boilers.

1. Higher efficiency.
2. Quicker steaming.
3. Compactness—little floor space and headroom are required.
4. Accessibility for thorough cleaning and inspection.
5. Elimination of many difficulties usually encountered in the repair of fire-tube boilers.

The gases of combustion pass around suitably located baffling to the induced draft fan and thence to the stack. Furnace draft is controlled by positioning of dampers "A" and "B".

A condensing-extraction turbine is

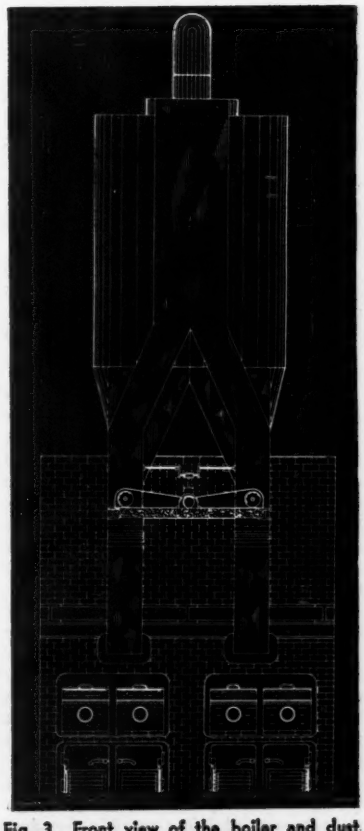


Fig. 3. Front view of the boiler and dust collector

shown. Steam extracted at about 10 psi would be used for feedwater heating, building heating and process purposes.

The ultimate selection of the proper generator prime mover would depend upon the final heat balance and many other factors. The initial selection favors a condensing-extraction turbine because of its low first cost, low maintenance, economy of space and foundation, clean exhaust steam, no vibration due to reciprocating parts, uniform angular velocity, high efficiencies for large variation in load and effective utilization of steam at high temperature.

Feedwater would be pumped from the river through a self-cleaning strainer to the usual filter plant and water softener. The size and capacity of the water purification units would be small because practically all steam leaving the boilers would be returned as condensate, therefore very little makeup water would be necessary.

The floor plan arrangements Fig. 2 are designed to give maximum availability with a minimum of time and effort. All boiler auxiliaries such as boiler feed pumps, chemical feeds, condensate return tanks, etc., would be located in the designated area behind the machine shop. This location would enable the boiler operator to easily check and operate all equipment to maintain continuity of operation.

Use of Overhead Crane

The main turbine, air compressor, synchronous condenser (plants of this type frequently have synchronous or static condensers to improve power factor which gives a substantial reduction in costs of purchased power) and machine shop set side by side in line. Too often, the tendency in small installations is to locate different machines in separate rooms, making it difficult to handle heavy parts when overhauling the machinery. The in-line arrangement permits an overhead traveling hoist to service all utilities as well as the machine shop.

The wall around the machine shop would be about four feet high. This enables the turbine operator to do miscellaneous work in the machine shop while still being able to observe any unusual changes in the turbine room.

All necessary switchgear would be located convenient to the mechanism it controls. One arrangement that might be desirable would be a turbine speed control and kilowatt meter on the boiler control panel. The auxiliary turbine control would enable the boiler operator to control the turbine load according to the amount of fuel available and facilitate the starting and shutdown operations.

Figure 3 is a front view of the boiler and dust collector showing some of the construction details that have already been mentioned. The dampers would be operated by an air-controlled piston. The fuel feed would use a speed control that would make possible a variation from zero to maximum.

The dust collector and all ducts would be made up of metal heavy enough to make welded joints possible. Sawdust traveling at a height velocity will erode metal but very little even over a period of many years. The welded construction would eliminate the possibility of sawdust blowing out into the boiler room.

The bad conditions outlined at the beginning of this article have continued to exist for many years. It is apparent that the boiler efficiency must be very low, probably about 50 per cent. Another considerable loss is heat in the steam exhausted to the atmosphere. Using the suggested Dutch oven furnace and water-tube boiler will generally raise the boiler efficiency to about 75 per cent. The condensing turbine utilizes the wasted exhaust steam. These savings will increase the steam and kilowatt capacity so much that the new power house would, to a considerable extent, pay for itself after a few years of operation.

How to Utilize Excess Wood Waste

The big problem around any woodworking plant is the disposal of wood waste. One argument in favor of the lower efficiencies is that greater quantities of fuel can be burned although considerable heat is wasted. The solution in this case is to burn the fuel as effectively as modern methods will permit and put the excess power generated back into the purchased power system. Then work out a reciprocal agreement with the Utility whereby the Utility would pay for the kilowatts added to its system.

The usual practical engineer to be found in these plants is progressive and has many good ideas that he would like to put into practice. The difficulty is that small enterprise owners cannot be made to realize the economy that accrues from the utilization of modern methods of steam and electric generation.

The general public still thinks of steam in the terms of the pick and shovel days, the modern conception being confined to the practical and technical men affiliated with modern plants. Like the new operator who does not know what questions to ask, small business management does not always know the constituents of good engineering, therefore in most cases conversion from the old to the new will occur only when power engineers step in and take the initiative.

Step-by-Step Operation of Drum Switches

This is a detailed description of how changes were made in a motor operated drum switch to adapt it to step-by-step operation. Since drum switches of this type are in common use, the arrangement used may be of interest to others

By A. H. BEILER

Electrical Engineer
American Gas & Electric Service Corporation

DRUM SWITCHES for varying the speed of alternating current induction motors are frequently arranged for remote operation so that the speed may be altered automatically or by an attendant from some central control point. The drum is rotated by a small pilot-motor, generally of the split-series field type, and this motor is operated in the forward or reverse direction by energizing it through one or the other of its two series-field coils. This is not usually accomplished directly from the "Fast" and "Slow" push-buttons, but by the intervention of "Fast" and "Slow" pilot-relays whose coils are energized by the push-buttons and whose contacts close the circuit to the pilot-motor.

Standard Requirements

Most motor-operated drum switches have, besides the main segments which take out rotor resistance, a number of additional features among which are the following:

1. Contacts to serve as limit switches to limit the maximum travel of the drum in either direction.

2. A contact closed only in the off-position to insure that the drum is in the all-resistance in position before the primary contactor or circuit breaker can be closed.

3. A set of "notching" segments which light lamps to indicate when the drum is centered on a speed position.

4. Another set of notching segments used for interlocking.

These latter are frequently connected to function as follows: When the attendant depresses a speed-change button, the pilot-relay becomes energized and seals itself in through one of the notching segments after the drum has started moving. The attendant may, therefore, release the button and the drum will continue to move one notch. If, however, the attendant does not release the push-button, the drum will continue its motion until such time as the button is released or the limit of travel has been attained.

Special Requirements

Requirements for pilot motor-operated drum switches are fairly uniform and it would seem that the features described above would provide almost any mode of operation that might be required. However, at one of the plants with which the writer is associated, the complaint was made that the drum moves so fast when the speed-change

button is depressed, that the operator does not have the time to release it before it has passed the desired point and has started to move to a new speed position. What was required was a mode of control that would move the drum only one notch at a time regardless of how long the operator kept the speed-change button depressed. In order to move to a second notch, he would have to release the push-button and depress it again.

How Requirement Was Met

It was rather surprising to find that standard control connections for this mode of operation were not available from the larger manufacturers of drum switches. Some of these switches, manufactured in recent years, have a special contact arrangement for this purpose but the drum switch illustrated in Fig. 1, being of an older design, did not have these facilities. Accordingly, the following control scheme, utilizing two auxiliary relays, was worked out to perform the required functions. When the operator depresses, say, the "Fast" push-button, the corresponding pilot-relay becomes energized and one of its contacts closes the pilot-motor circuit. The drum starts to move and, as soon as contact is made by a notching segment at Terminal 1 of the drum, Relay X becomes energized and one of its normally-open contacts seals in the pilot-relay. Relay X also closes the circuit of Relay Y, which latter seals itself in by one of its normally-open contacts and takes the control away from the push-buttons by means of its normally-closed contacts. The drum continues to move to the end of the notch independently of the push-button and then stops even though the operator may still be depressing the button, because Relay Y remains energized and keeps the push-button circuit open.

When the push-button is released, Relay Y becomes de-energized and closes its normally-closed contacts in readiness for the next operation.

One normally-open contact of each pilot-relay is used to energize the pilot-motor; the second one insures the sealing in of only one of these relays at a time.

The limit-switch contacts, 3 and 4, limit travel of the pilot-motor.

The usual interlocking is provided via the normally-closed contacts of the "Fast" and "Slow" push-buttons so that if both are depressed simultaneously, no operation will take place.

An undervoltage-relay is connected in the customary manner insuring that voltage be on the primary circuit before speed can be increased and arranged to automatically return drum to the off-position on loss of voltage.

It is possible to obtain the required performance, utilizing only one auxiliary relay. Such a relay requires three normally-open and three normally-closed contacts and these must be adjusted to function—to either open or close when the coil is energized—in the sequence of A, B, C, D as indicated. Thus Contact A closes, then B opens, then C closes and finally D opens. Referring to Fig. 3: The "F" pilot-relay is energized when the "Fast" push-button is depressed. The drum starts to move and as soon as contact is made by a notching segment at Terminal 1 of the drum, Relay X becomes energized and seals in the pilot-relay through Contact A. It then opens the push-button circuit to the pilot-relay by Contact B, seals itself in via the push-button circuit and Contact C and finally disconnects itself from Terminal 1 in the drum by Contact D. This arrangement makes the closure of Relay X initially dependent on the contact in the drum but this dependency is then transferred to the pilot-relays whereas Relay X finally maintains its circuit closed independent of the contact in the drum but still dependent on the push-button.

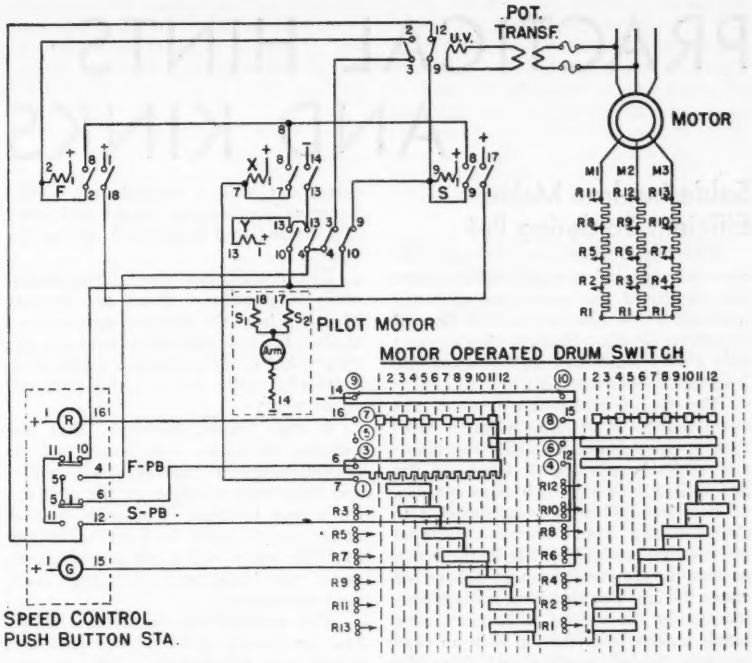


Fig. 1. Wiring for step-by-step operation of motor operated drum switch

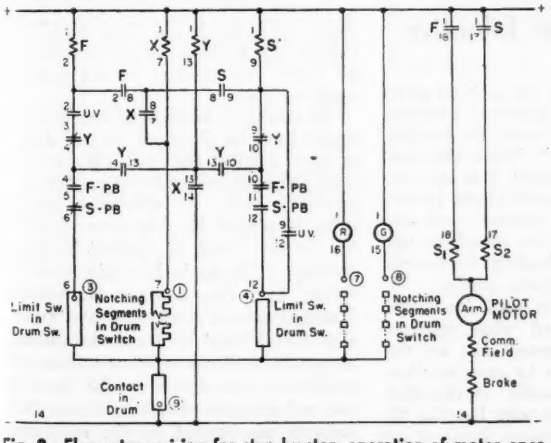


Fig. 2. Elementary wiring for step-by-step operation of motor operated drum switch

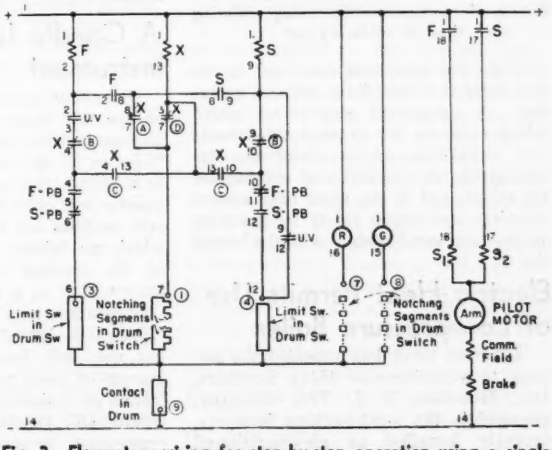


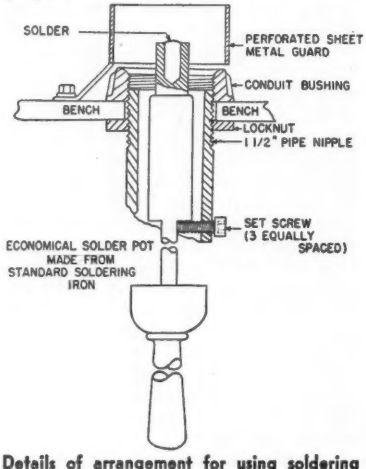
Fig. 3. Elementary wiring for step-by-step operation using a single additional relay

PRACTICAL HINTS AND KINKS

Soldering Iron Makes Efficient Soldering Pot

THE USE OF STANDARD soldering irons especially adapted as small soldering pots has facilitated the production of small instrument-type motors in one of General Electric's Works. Because they present only a very small area for oxidation, the irons are saving materials.

The improvised solder pot, which was developed by R. H. Bainbridge, a foreman, is easily built. A standard medium-size soldering iron tip is faced off flat and drilled with a ¼-inch diameter hole, ¾-inch deep. This tip is reassembled to the soldering iron. The iron is then mounted vertically in a hole in the bench so that the tip projects about two inches above the top. The mounting is made permanent by the use of a standard pipe nipple locked from the top with an electrician's conduit bushing and from the bottom with an electrician's lock nut. The iron is held in the bushing by three set-screws which clamp the body of the iron proper.



Details of arrangement for using soldering iron as soldering pot

Only the insulation contained in the iron itself is required for efficient operation. A perforated sheet-metal guard which encircles the exposed tip permits free circulation of air about the tip, eliminating the possibility of overheating the solder, and at the same time assures complete operational safety by guarding against accidental contact with the heated tip.

Electric Heat Permits Use of Low-pressure Boiler

ELECTRIC HEAT has provided the answer to a problem at Haag Brothers, Inc., Hoboken, N. J. This company, engaged in the meat-packing business, recently installed an air-conditioned oven for smoking meat. Supplementary equipment was a smokehouse conditioner which furnishes smoke and properly heated and humidified air to the oven.

The conditioner must be provided with 400 pounds of steam per hour at 50 psi to heat the air to a temperature of 240 F as it circulates over an arrangement of finned steam coils. This ordinarily calls for a high-pressure steam plant.

It was found, however, that the existing structure was too small to accommodate a high-pressure boiler, and there was no room on the grounds for a new building. The only type of boiler which could be installed in the available space was a low-pressure sectional type boiler with 15 lb gage pressure maximum.

The smokehouse conditioner could heat air to only 200 F at this pressure, which was insufficient to operate the oven properly. It was necessary, therefore, to boost the air temperature by a minimum of 40 F by other means. Electric heat was called upon to do this, since a constant and quick heat supply was needed.

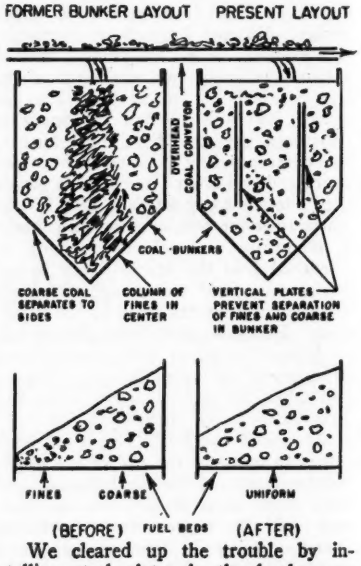
Eight General Electric finned Calrod heaters, with a total connected load of 48 kw, were installed in the circulating ducts through which the air passes from the conditioner to the oven. The heaters were installed immediately beyond the steam coils, and were arranged with hand-controlled switches so that the operator can select the heat volume to satisfy any demand, depending upon the work being done in the oven.

The low-pressure boiler is now doing the job as well as a high-pressure boiler would do it. In addition, the cost of operation is less than the estimated cost for operating a high-pressure boiler. The oven and smokehouse conditioner were furnished by the Niagara Blower Company, and the customer's engineer in charge of this application was Mr. O. Knipping.

Preventing Coal Segregation

By CASH HUGHES
Chief Engineer, Cincinnati Milling Machine Co.

THE ACCOMPANYING sketch shows our solution of a coal segregation problem we encountered in our overhead bunkers about a year ago. The fines packed down in the center of the bunker, the coarse stuff slid off to the sides and the uneven flow into the stokers caused uneven burning.[1]



We cleared up the trouble by installing steel plates in the bunkers as shown in the sketches.

[1]See "How Coal Sizing Affects Stoker Operation" by de Lorenzi, Power Plant Engineering, June 1943, Page 96.

LETTERS AND COMMENTS

A Candle Is an Effective Instrument

I WAS interested in the problem given on the title page of Practical Engineer section, October Issue under the heading "Give us all the facts." While this may be a hypothetical question[1], it is one frequently met with in small plants in certain sections of the country, and one which we believe can be solved by use of the simplest combustion instrument known, that is, a common candle.

Engineers who have read Joe Hays' "Fireman's Bible," and what engineer has not, will have noted that on the margin of many pages he gave an illustration of a lighted candle. Having had considerable experience with Douglas fir slabs, cord wood and "hog fuel," we believe the problem is entirely one of air leaks, not peculiar to the type or grade of fuel.

In solving a problem of this kind we would have an Orsat on the job but it is quite possible that the leaks are beyond the point where Orsat readings are generally taken. As elimination of the leaks progressed the improvement inside the furnace would be checked by Orsat readings. The air leaks might be in the setting (see Fig. 1, Page 84, October POWER PLANT ENGINEERING and especially "B," "F" and "G") and cool entering air would condense resinous matter, and precipitate that matter in the form of soot and creosote onto the tubes and other surfaces also cooled by the infiltrating air.

[1]It was not, it was an authentic question sent to us by a west coast reader. Ed.

If the plant is an old one, the trouble could be in sections of the smoke and gas vent beyond the breeching and damper. We have in mind one case of this kind. Here the fireman, firing ordinary hog fuel which is composed of saw dust and ground up slabs of Douglas fir, western spruce or hemlock, red or yellow fir or whatever the mill happened to be cutting that day, attended his regular Sunday morning services, digging soot and creosote scale as well as ashes out of his boiler setting and in addition to that, the neighbors spent days scrubbing and brushing up the soot and cinders. A nearby bakery kept several persons scrubbing continually. We lived nearby, and one day in self defense I

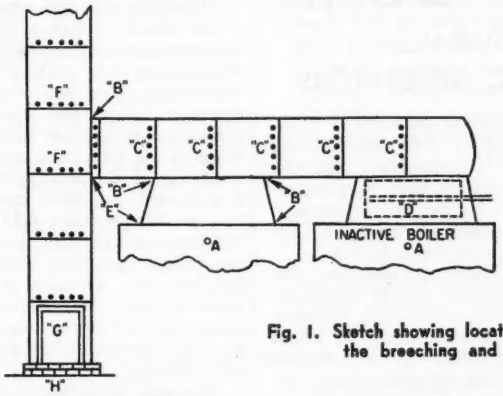


Fig. 1. Sketch showing location of leaks in the breeching and stack

took the Orsat and candle, draft gage and pyrometer and visited the plant.

An interesting story could be written about what we had to do to that setting and to the adjustment of the blower. While CO_2 went up and efficiency increased, trouble with soot and cinders continued. As the problem states weather had something to do with it, at that time we were having a long drawn-out spell of weather. On one clear day, however, with smoke going straight up, we looked into matters beyond the breeching or as shown in Fig. 1.

Our findings were as follows:

A—Our Gas Sample here showed good CO_2, fair draft and normal flue gas temperature.

B—Leaks where smoke box joined the breeching had been tightened.

C—Minor leaks all along this pipe at all joints, largely where they had hammered it to loosen soot. (Candle flame turned in.)

D—Damper on inactive boiler wide open. We closed that.

E—Large leaks around smoke pipe where it joined collar of stack and flange on stack loose. (Leaks that pulled flame from candle.)

F—Minor leaks at all joints of stack. (Candle flame turned in.)

G—Excessive leaks around frame of cleanout door. Cleanout door badly buckled. (Candle here was impossible.)

H—Stack resting on brick base where very poor plaster had been used and bricks all loose.

All these air leaks were inside the boiler room and in full view of all who passed by. Various so-called Combustion Engineers had worked on the problem. One added to the stack, another took that off. One added a blower at the base of the stack and when that failed, took off his part and left the opening as we found it.

About the only thing I had to go on was what Joe Hays had said in his book, "You can't make steam in a sieve," and "Keep them tight" and I took this to mean, keep them tight from the firebox to the top of the stack. Soot and creosote are fuel and if combustion is correct these will be consumed and give little trouble. All these leaks act as a check-draft, calling for excess blower capacity to force circulation before full combustion is possible.

We stopped all these leaks temporarily until more permanent repairs could be made. The fireman was again able to attend church services with his family Sunday morning, and within a few weeks the firm had had all the leaks permanently sealed.

I ran across a similar case with an all steel, hrt boiler where the fireman was taking out a barrel of soot each Sunday morning. We noticed a crack all around the cleanout doors which were at the end of the boiler opposite from the firebox and recommended that these doors be completely sealed with furnace cement. This is shown at A in Fig. 2. The fireman objected for he said he had to get in there every week but I insisted that even if he did have to break the seal with a chisel, it was worth the experiment. Therefore, the job was done and when the fireman was absent from the boiler room I put a mark on the seal where it would be broken if doors were opened.

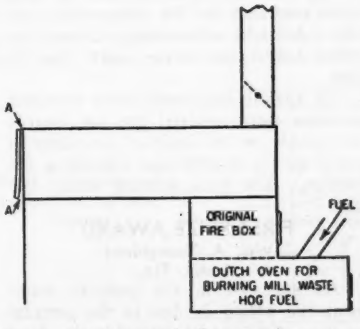


Fig. 2. Crack around cleanout doors prevented good combustion

After several weeks the fireman said that this had done no good but when I called his attention to the mark, he admitted that the doors had not been opened, nor had there been need to. Here also, the combustion engineers had recommended more stack.

Portland, Oregon — LEON S. LYON

Glad We Were Injected with the Same Kind of Blood

MAY I ADD a belated comment on the swell article written by Pvt. Bill Green in one of the recent issues of POWER PLANT ENGINEERING. I am glad to know that no matter where they go, the true engineer's love of soot and grease always lingers even in the Army.

As Bill G. has his dad to thank for his guidance into the engineering field, I have my two older brothers to thank, and they are good engineers. One is a chief engineer with unlimited tonnage licenses in steam and Diesel; the other is a Chief with unlimited tonnage in Diesel, so you can see where my guidance came from and, Bill, I'm mighty glad we were sensible enough to follow this path. I've found that from time to time it seems a loss or rather a waste of time to be in this trade, but reading good engineering magazines and reading about the education and background of some of our top engineers in this power plant field, makes me feel nothing is impossible in the way of advancement, if a person keeps trying and keeping up with development as much as possible. Practical knowledge is fine and theory is good, but the combination put together can't be beat.

I'm as happy as you are, to feel that you got the break you wanted, to be firing in the Army; so from me to you the best of luck. The Army, I am quite certain, conducts correspondence courses, and since you are getting the practical knowledge don't forget to get some of the theory; it's all for your benefit later in life. But probably you don't need this advice; your dad has let you know these things. Mighty glad to hear you feel the way about your dad as you do and he feels just as proud of you. I feel swell about my two brothers being out in the U.S. Merchant Marine and don't think I wouldn't be out there if I didn't have to keep my family, also my dad who like your dad is the best friend in the world (just 88 years old).

I'm glad you feel as though the article on the training of operators was worth while. I put 6 years in the U.S. Coast Guard and almost that much time in the Merchant Marine, so you can see how much I'd like to get back for the duration. Bill, if you don't get this P.P.E. magazine at your camp, why not get your dad to send it to you? The time just flies looking forward to these engineering articles in this fine paper.

Hoping to see one of your articles in the near future.

Philadelphia, Pa. — WILLIAM T. MULLEN

How Would You Do It?

PROBLEM 31. TROUBLE WITH THE PARALLEL OPERATION OF D-C GENERATORS

IT IS CURIOUS how such a time-worn subject as the parallel operation of direct current generators can always start a good discussion among almost any group of operating engineers. Certainly, there is nothing new about parallel operation either in its technical or practical aspects that has not been fully covered in the many years that d-c machines have been operating in parallel but interest in the subject, apparently, never dies. Of course, there are always new and younger men coming into the field and they have to learn just as the older engineers before them did.

It was not entirely a coincidence that Problem 31 was presented in the same issue with an article on parallel operation by Mr. Nerenberg of the Crocker-Wheeler Electric Mfg. Co. Our Hero's problem and the article by Mr. Nerenberg reached us at approximately the same time and it seemed rather appropriate to present them together. While Mr. Nerenberg's article covers the essentials of parallel operation very well, in such a short discussion of the subject it is impossible to consider all aspects in detail and some matters were given only general attention.

One of these concerns the use of series shunts or diverters as they are sometimes called. Mr. Nerenberg in his article discussed the use of series shunts and he showed their use in his diagram of two generators for parallel operation, but he also pointed out that in cases where generators of different size are involved, such shunts are not always effective.

This was a point that so many of those who submitted solutions seemed to fail to appreciate. Series field shunts are very effective in adjusting the degree of compounding of a single generator but as shown by several of the contestants, a shunt on one machine is a shunt on all of the machines operating in parallel, and for this reason the trouble inherent in the problem cannot be overcome by mere adjustment of the series field shunts. The resistances of the individual series circuits must be adjusted by resistances in series with the field coils.

As might have been expected, we received many splendid solutions to Problem 31 and all of them attacked the problem from the standpoint that the compounding characteristics of the generators did not match. A number also suggested that the governors of the prime movers might be at fault.

These were really the only two possible solutions and the awards were made on that basis. Curiously enough, however, Problem 31 was based upon an actual case that was called to our attention some time ago and the trouble was overcome not by any of the methods suggested but by simple and careful adjustment of the field rheostats. In the actual case, any attempt to divide the load proportionately between the respective machines caused severe sparking at the brushes.

As a means of finding the cause of the trouble, the operator installed a portable recording, shunt type ammeter in the 150 kw unit equalizer and found a circulating current of some 75 amp between this unit and one of the 300 kw machines. Adjusting the field rheostats to give proper voltage and zero current in the equalizer caused a slightly disproportionate loading of the two units but commutation and voltage regulation was improved.

After that, a 200 amp differential, shunt type ammeter was installed on the switchboard, with the shunt in the equalizer of the 150 kw unit. With this arrangement paralleling was done by adjusting the field rheostats until this ammeter read zero and the voltage was correct. A slight unbalancing of load resulted but it was never more than 70 amp.

As already mentioned many excellent solutions were received but the awards were made on the basis of simplicity in analyzing the trouble and suggesting the solution. The prize winning letters follow:

FIRST PRIZE AWARD

Wm. A. Youngblood
Austin, Tex.

As indicated in the problem statement the arcing is due to the unequal loading of the generators when the three are operated in parallel. One of the conditions which must be satisfied for proper operation of compound wound dc generators in parallel is that the series field resistances of the various generators must be inversely proportional to the loads of the various generators considered.

While operating the two 300-kw machines in parallel without the 150-kw machine, Our Hero found no difficulty because the equalizer carried a circulating current to offset any difference between the resistances of the series fields of the generators. Also the two generators were probably built at the same place and time with the result that their series field resistances were nearly equal to begin with.

When the new generator was added, it had either too high or too low series field resistance considering the other generator series field resistances. With too high a series field resistance the smaller generator caused the other two larger generators to assume more than their share of the load. The excessively high resistance of the small generator series field caused too little current to flow through this generator field with the result that the field flux dropped off and the 150-kw machine voltage dropped. Sparking then appeared on the 300-kw machines here. Had the series field resistance of the smaller machine been too low, the opposite would have been true with sparking of the small machine.

The usual procedure to change degree of compounding of a compound wound generator is to use a diverter, or resistor shunting the series field. The lower the shunt resistor, the lower the degree of compounding. This method, however, cannot be used when two or more compound generators are operated in parallel, for shunting one of the series fields is the same as shunting all of them at the same time. In parallel operation the change in compounding must be accomplished by means of resistance in series with the series field of the generator.

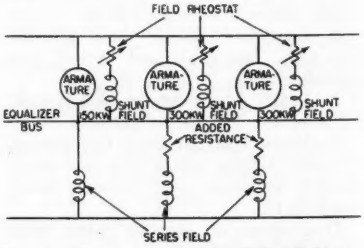


Fig. 1. Proper connection of the fields as suggested by W. A. Youngblood

In the instance indicated in the problem, Our Hero seems to have too high resistance in the series field of his small generator, since the other two generators are sparking. The solution of the problem lies in adding to the resistances of the series fields of the two large generators until all resistances of series fields are inversely proportional to the loads of the generators. The added resistance must be placed in series with the series field of the generator *between the series field and the equalizer connection.* Other-

wise the added resistance would merely serve as a power loss in the circuit with no beneficial effect. Proper connection of the fields is indicated in the accompanying diagram.

SECOND PRIZE AWARD

R. S. McComb
Delaware County, Pa.

The trouble in Problem 31 may be in the equalizing equipment. The sketch showing the three generators in parallel does not show the series shunts which normally are connected across the series fields of compound direct current generators.

These series shunts are arranged to give either a flat or rising voltage with increase in load. When generators operate in parallel, each machine should have the same characteristics.

A series resistance placed in series between B and C (Fig. 2) may help if the series shunt K on the 150-kw machine is large and has too low a resistance. If this is the case, the current through this resistance is too great, robbing all of the series fields of the machines in parallel. This would cause them to act as shunt machines.

A shunt on one machine is a shunt on all machines in parallel as shown in Fig. 2.

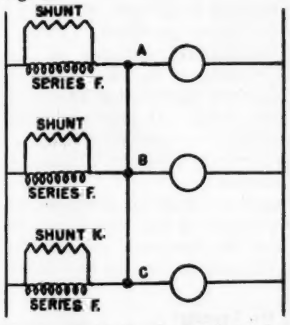


Fig. 2. R. McComb sketch to show that a series field shunt on one machine is a shunt on all machines. A, B, and C, equalizers.

The 150-kw machine may be undercompounded, that is, its voltage may drop with increase in load. If this is so more resistance should be put in the shunt K, and the series resistance suggested between B and C may not be necessary. Non-inductive shunts should be used if the load changes rapidly.

The equalizer prevents unstable operation by allowing current to flow through a low resistance circuit from the generator or generators tending to produce the higher voltage, through the generator having the lower voltage. This increases the voltage on the latter machine until it takes its share of the load.

The equalizer cables should be as large as the main cables. The resistance of the equalizer may be controlled by the selection of the proper size, and length of the cables. Care should be taken to have a clean equalizer switch. The prime movers, furthermore, should have the same load speed characteristics. The speed load curves of the engines or turbines should be almost straight lines and they may be manipulated to help the load curves of the generators.

Problem 32
Mixing Coal and Coke Breeze

Our Hero has a simple yet sort of puzzling problem this time. He has recently installed a new steam generator in this plant fired by a spreader type stoker. Very excellent results are obtained with this new installation when it is fired with a mixture of coal and coke breeze —a 50-50 mixture. Both fuels are delivered by railroad car and stored on the ground by means of a portable conveyor or delivered directly into a track hopper from which a conveyor carries the fuel to overhead storage bins in the boiler room. A travelling weigh larry carries the fuel to the stoker hoppers.

The problem confronting Our Hero is that of mixing the two fuels uniformly. He can set two men at work shovelling and mixing two piles of fuel by hand but that involves too much work and furthermore labor is scarce. The overhead bunker has several compartments each with its own fuel gate. Thus, it is possible for the larry to first take a load of one fuel and then another but this does not effect thorough mixing. The fuel handling system is a conventional one, involving a bucket conveyor and a travelling trip over the bunkers.

If you were up against a proposition like this how do you think you would attempt to solve it? Assume that you can spend a reasonable amount of money doing so. Write out your solution in a letter of not over 1000 words. We will award a $25.00 war bond for the best solution and prizes of $10.00 and $5.00 respectively for the second and third best solutions.

Entries for this contest should be mailed not later than January 31 and should be marked Problem 32. Address all letters to the Contest Editor, Technical Publishing Co., 53 West Jackson Blvd., Chicago 4, Illinois.

THIRD PRIZE AWARD

Tom Owens
Plant Engineer, Jewel Tea, Inc.
Barrington, Ill.

There are still a few of us d-c construction engineers in circulation to help pick out the bugs in d-c power plants. In problem 31 I offer the following comments:

Compound generators of different size or current capacity may be coupled in parallel, provided, of course, their voltages are equal and provided also that the resistances of the series field coils, together with their leads to the bus bar, are inversely proportional to the current capacities of the several generators; that is, if a generator produces twice as much current, its series coil and lead should have half the resistance. It is further necessary that the several generators should agree in their action, so that a given increase in load will produce the same effect upon their voltages. If they are not in agreement, they may be adjusted by slightly increasing the resistance of the series coil of that generator which tends to take too large a share of the load. This may be done by simply interposing a few extra feet of conductor of the same current capacity as the series coil between the latter and the main conductor or bus bar. In my diagram Fig. 3 I show a shunt marked letter "Z". These shunts are almost always used to adjust the effect of the series coils in compound generators, they operate properly in the case of generators working singly but are *worthless for generators in parallel.* The resistance of the series coils themselves must be adjusted as explained above when two or more compound generators are run in parallel.

If Our Hero will follow my suggestions I know this will cure his headache.

Honorable Mention

Among the many other excellent letters received the following one from Prescott Nichols of Reading, Mass., deserves particular attention. His method of checking up on the voltages of the three machines by simultaneous readings should be noted and his suggestion to use a cut and try method of arriving at the proper resistances to be used in series with the series fields rather than to try

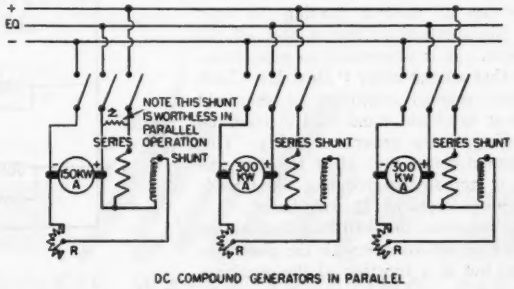


Fig. 3. Diagram of connections by Tom Owens

to calculate them is good advice. Here is what Mr. Nichols writes:

"As mentioned in the problem, the condition is due to improper distribution of the load and since the original 300-kw units operate together in a satisfactory manner, the trouble must be with the new unit. As a check, the ammeter of each machine should be read by 3 different men at the same instant on a signal that could be given with a police whistle. Readings should be taken under various amounts of load and curves plotted of each machine load against total load. These curves should be parallel but it will probably be found that they are not and that the new unit is mainly at fault.

"Next, one of the 300-kw machines should be operated with no load and its normal voltage and the rpm noted. Full load should then be applied without changing the field rheostat and the voltage and speed recorded. A similar test should be made with the new unit starting with the same no load voltage. If the speed changes of the two units are not the same *percentage* the governor of the new machine should be adjusted to make them so and the test repeated. Then if the voltages at full load are found to be different, the shunt resistance on the series field of the 150-kw unit should be adjusted to make them equal.

"Next, try running all machines together. If they still do not operate properly, resistance must be inserted in series with the series field of one or more of the generators using a cut and try method until good results are obtained. Try the new unit first. If full data as to all generators, engines and leads was available it might be possible to calculate what the required resistance would be, but at best this would be a complicated proposition and might not give too good results.

"From the description it looks as if the governor of the new unit might be at fault and that this machine first grabs too much load and then drops it and has a tendency to run as a motor which puts too much load on the original machines and causes them to spark.

Suggestions by C. G. Clark

C. G. Clark who won the second prize award in the High Pressure Still contest presented in the September issue, submitted a very good letter and some of his comments deserve mention. As he points out sparking at the brushes of a d-c generator can be caused by a variety of faults but since it was stated definitely that the trouble in the case of Problem 31 is one of unequal loading, he confines his solution to that aspect of the problem. It is interesting to note, however, that among other things, Mr. Clark suggests manual operation of the field rheostat to obtain equal load distribution according to the generator rating. This suggestion comes very close to what was done in actually overcoming the trouble on which Problem 31 was based. Actually, however, the final load distribution was not in accordance with the generator ratings but as a function of the sparking. The condition finally obtained was a slight condition of unbalance. This probably was not the most efficient solution but it was the most expedient. The major portion of Mr. Clark's letter follows:

"The wiring diagram for the three generators is given in Fig. 4. The resistance through each path from the equalizer A to the positive bus B must be inversely proportional to the rated full load currents of each generator to prevent current flow in the equalizer. Since generators 1 and 2 are equal in rating, and generator 3 has a rating one-half the others, the series field circuit resistances must be in the ratio 1:1:2. The shunts across the series field circuits should be of such values that the compounding is as nearly equal as possible on all generators. Varying the value of the series field shunt resistance on one generator will affect the compounding of all generators in service. The adjustment that can be made by varying the resistance of the series field shunt or by adding resistance in series must not vary the ratio stated above.

"The adjustment of compounding must take into consideration the speed regulation of each steam engine. If the speed regulation of each engine from no load to full load is not the same it should be made so. This assumes that the engines have the same type of speed regulating equipment. If the engine governors on the three engines are not the same type it is probable that the speed regulation cannot be made identical. In this case each governor should be adjusted to give the best performance of which it is capable.

"It is probable that the speed regulation of the 150-kw unit is greater than that of the other two units. The actual regulation from no load to full load should be accurately determined. If this engine has a flywheel mounted spring operated governing system, it is probable that the spring is weaker than required. This common fault can be corrected by adjustment within certain limits. Beyond the limits of adjustment possible it is necessary to replace one or more leaves or the entire spring depending on the conditions found. Sometimes adding one or two leaves of slightly increased thickness will provide the additional stiffness necessary for proper regulation.

"Apparently the three generators have voltage characteristics as shown by the graph Fig. 5. Under operating conditions the generated voltage of the 150-kw unit falls below the others because of poor speed regulation or improper series field adjustment as shown by curve I Fig. 5. Under these conditions the 150-kw unit either takes a very small load or more likely is driven as a motor.

"There are three possible methods of correcting the trouble. The best method to use will be found only after all the conditions are accurately known. The methods suggested are given below:

"1. (a) Determine the speed regulations of all units from no load to full load as accurately as possible. Make any necessary adjustments or repairs to speed governors to obtain first class performance of the type fitted. (b) Obtain by test, or from the generator manufacturer, the compounding curves for each unit and correct them as necessary for the exact speed regulation found. On the basis of compounding curve comparisons adjust the series field circuit resistance values to equalize generated voltages at full load.

"This method is the most desirable but may not be a cure with the existing equipment. In any case the above procedure should be followed before taking the alternative courses given below, as these adjustments cover only normal installation for proper operation.

"2. Use manual regulation of the shunt field rheostat of the 150-kw unit to obtain equal load distribution according to generator rating. If load variations are not too rapid or extreme and an attendant is normally present, this may be the best solution.

"3. Install a voltage regulator on the shunt field circuit of the 150-kw unit so adjusted that the compound curve is the same for this unit as for the two larger generators."

Equalizing the Equalizer

J. E. Sullivant, post engineer at the S. H. A. A. F., at Salina, Kan. makes some very pertinent suggestions for correcting inequalities in the resistance of the equalizer. The trouble, he points out, may be due to high resistance in certain places in the equalizer leads and connections. In the first part of his letter he discusses the problem from the standpoint of improper compounding and since this part of his discussion is essentially the same as that of the others already given, we will not quote from that part of his letter. Regarding the

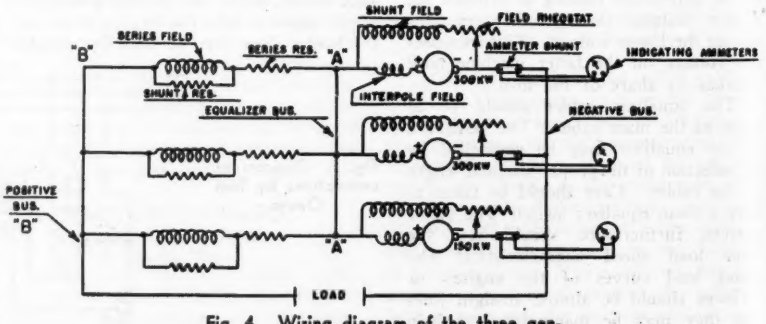


Fig. 4. Wiring diagram of the three generators by C. G. Clark

Full Steam Ahead, AMERICA!

IT has been estimated that 60,000 locomotives would be required to handle the volume of traffic now being handled by 39,000 if it were not for modern water treatment, much of which is being supplied by Nalco.

•

According to one authority 0.1 inch of scale in a boiler will cause heat losses as high as 15%. More than 4000 power plants using the Nalco System are eliminating such losses.

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Floating boilers can't take time out. A Nalco conditioned steamship recently set an all-time mileage record on the Great Lakes for one season.

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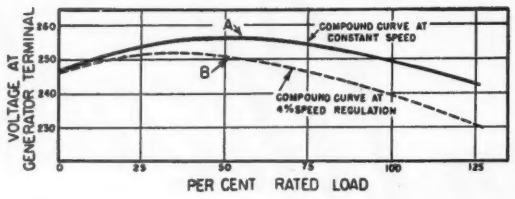

Fig. 5. Graph showing the compounding characteristics of the generators as analyzed by C. G. Clark

equalizer, we quote from Mr. Sullivant's letter as follows:

"The unequal loading may be due to high resistance in certain parts of the equalizer connection.

"The equalizer must be of very low resistance and in no case should be of smaller circular mil area than the leads to the largest generator; also equalizer connections should be made as short or close as possible to the units.

"In some installations where equalizer bus is carried on switchboard and additional units are connected, sometimes, considerable distance away where it is necessary to use longer leads, and as result we get more resistance in certain parts of the equalizer connection which in return causes unequal loading of units.

"In order to determine if your trouble is in the equalizer connection without much expense and time involved, connect a temporary equalizer of sufficient cir mil area with switches as in Fig. 6 from the positive terminal of first unit to positive terminal of second unit, and positive terminal of third unit, directly between the machines and as short as possible. Now put all 3 units on the board; if 1 unit still tries to carry overload this can be prevented by installing a small resistance in its equalizer connections. Sometimes an iron washer under terminal lug will be sufficient.

"After making this test and equal loading of all units is apparent then make permanent connections and installations as shown in Fig. 7.

"Since the equalizer switch and the switch in the positive lead of each machine only differ in potential by the small voltage drop in the series coil they can be placed side by side and some installations are located on a stand between the generators and equalizer bus run under the floor. Make all leads same size and length if possible."

Comment on Other Letters

John A. Graham of Pittsburgh gave some excellent detailed advice in regard to finding the cause of the trouble. He points out that an unbalanced condition in the loading can easily be determined by inspection of the switchboard instruments. Check the operation of the valve gear of the engine for evidence of laboring in the engines. Next look at the connections, starting back of the board and going all the way back to the generators. In an old plant many of the soldered and bolted joints may have loosened up enough to cause increase in resistance. "Our Hero's remark that the equalizer did not help much is a clue that there is something wrong here. A good efficiency test of the equalizer is to 'tease' up the voltage when putting the generator on the line by repeated momentary closing of the equalizer switch. If this action does not hasten the building up of voltage, it is an indication of something wrong in the equalizer circuit—possibly a high resistance or a disconnection. . . . Are the brushes evenly spaced around the commutator? Some years ago I corrected a noisy and brilliant sparking condition by the simple act of equalizing the brush spacing. Do the brushes cover no more than the correct number of bars? Do the brush shunts or pigtails make good electrical contact so as to divide the load evenly? If no shunts are used, clean the surfaces on the brushes and brush holders."

Among the others who submitted very good analyses of the problem were, F. C. Beckwith of Toledo, Ohio; Conrad Proebstle of Atlantic City, N. J.; Walter Heidecker, Chicago, Ill.; A. F. Bremilst of Wrentham, Mass.; G. E. Marsh, Washington, D. C.; Leslie Griscom of Philadelphia, Pa.; Fred E. Gould, Dalton, Mass.; Thomas W. Benson, Philadelphia, Pa.; and Julian P. Calvert of Flushing, New York.

Mr. Calvert's letter was quite short and much to the point so is presented as follows:

"Problem No. 31 presents three (2—300-kw 250-v and 1—150-kw) compound-wound d-c generators connected short shunt and operating in parallel on an equalizing bus. The 300-kw units are an old installation and they operate satfactory together in parallel. The 150-kw unit is a new installation, a reclaimed job, that operates fine alone but when on the line with either or both of the other units causes undue sparking on all machines. Generators are similar in design but confirming data is omitted. All units are engine-driven and it is assumed that their governors will maintain the desired constant speed for all load ranges.

"The fundamental requirements for parallel operation of d-c generators are: (1) The total generator resistances (armature and series fields) must be inversely proportional to the machine current capacities. (2) The generator terminal voltages of each machine must be the same.

"To maintain proportionate divisions

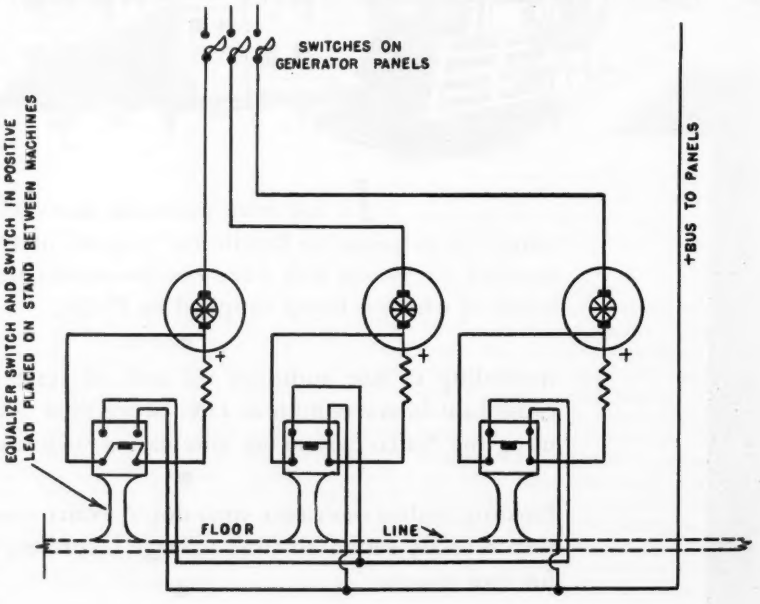
SWITCHES ON GENERATOR PANELS
+BUS TO PANELS
EQUALIZER SWITCH AND SWITCH IN POSITIVE LEAD PLACED ON STAND BETWEEN MACHINES
FLOOR
LINE

FIG. 7

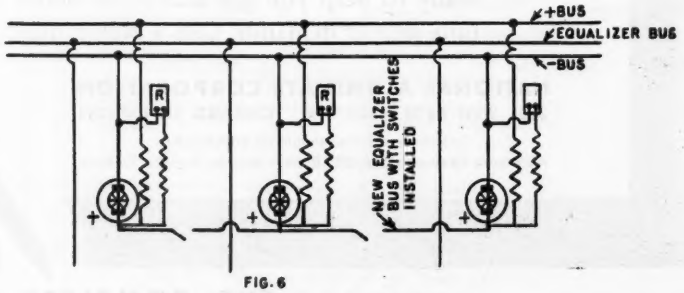

FIG. 6

Figs. 6 and 7. Diagrams by J. E. Sullivant

Simplicity of Design Means Easier Maintenance

SERVICING IN THE LINE SAVES TIME . . . . . .

. . . and it saves the valve, too, because regular servicing not only keeps the valve in top condition and gives it longer life, but it reduces the possibility of having to make extensive repairs later. The simplicity of Lunkenheimer design makes all parts easily accessible for checking any first signs of lagging operation, and the taking of precautionary measures.

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of load on various generators properly at all intermediate points, they must have identical external characteristics for various per cent loads. If the external characteristics are not identical one generator will carry more than its share of the load.

"Suggest that no load losses on each unit be obtained and from this the external characteristics can be calculated. Undoubtedly this will reveal that the external characteristic of the 150-kw generator differs materially from either of the 300-kw generators. If the external characteristic of the 150-kw unit is higher than the 300-kw unit it will be necessary to introduce a diverter *in parallel* with the series field (the resistances of the conductors from the synchronous bus should be inversely proportional to the capacities of the machines). This will produce the effect of lowering this external characteristic and if the proper resistance is used will make it coincide with that of the 300-kw generators."

Nearly all of these contestants analysed the problem correctly, though a number of them seemed to feel that the trouble could be corrected by simply adjusting the resistances of the series field shunts. With generators of different ratings this is not necessarily so.

On the whole, however, practically all contestants displayed an excellent knowledge of the principles of parallel operation and we regret that space does not permit us to present more of the solutions here. At any rate, Our Hero or anyone else who runs into trouble of this kind should have no difficulty in overcoming it after reading these discussions.

Questions And Answers

Question No. 244

Why Does HRT Setting Crack and Bulge?

WHAT WOULD cause the outside walls of a practically new HRT boiler setting to crack and bulge so badly that they are practically collapsing?

There are two HRT boilers set in battery. The boilers are suspended from overhead steelwork. The cracking and bulging are not like the ordinary cracks that you expect to get in solid wall boiler settings in normal operation but are much worse. There are buckstays on this setting but they didn't seem to do much good.

Do you know where I can get a complete set of directions or specifications for HRT boiler settings, giving directions for providing for expansion, proper foundations, anchoring of firebrick to outside wall, location of buckstays and such details, so that I can check up this setting to see what might have caused these walls to collapse?

Chicago, Ill. R. J. R.

Question No. 245

More About Fuses: How Should This Circuit Be Fused?

IF THE CURRENT in a two-wire a-c circuit is 62 amp and the electrical energy is consumed by lamps, how would you fuse the circuit?

I have been told that a 100-amp switch should be installed and protected by 50-amp fuses. However, I am of the opinion that the switch has to be protected by two 75-amp fuses. If I remember, Kirchoff's Law states that the same amount of current flows from the resistance as flows to it. After all, the lights in an alternating current circuit are resistances.

Which is the practical thing: a 75-amp switch fused with two 75-amp fuses or a 100-amp switch fused with two 50-amp fuses?

Camp Ellis, Ill. C. E.

Question No. 246

How Make Water and Steam Sampling Devices?

HOW CAN I MAKE sampling devices needed for taking samples of boiler water and steam from a 650-psi, 725 F boiler in an industrial power plant? Are these patented devices and would I be allowed to manufacture any of them just for my own use? If so, there is some copper and stainless steel tubing, removed from dismantled equipment, that I can use and I have various sections of old 650-psi pipe and some fittings—and a good welder. I know that various coils, chambers and plates are used in this equipment but do not know any of the details of construction or connections.

I understand there is a device called the Straub condenser for taking steam samples for analysis by the conductivity method. How is this constructed?

I also understand that some of these sampling devices include cooling or condensing coils made of one tube inside another and then coiled. What is the method of bending such a double coil? I could handle a single pipe but don't know about this double pipe coil bending.

Detroit, Mich. T.E.R.

EDITOR'S NOTE—*A number of devices for water and steam sampling have been developed. The Straub condenser referred to in the question is correctly named the Straub and Nelson degasifying condenser, described in Trans. ASME, Vol. 63, No. 7, Oct. 1941, pp. 645-653. Another device to accomplish the same result is the Joos atomizing degasifier also described there. Details of this were given in Power Plant Engineering, March, 1941, pp. 69-70. A complete survey of the whole subject of boiler water and steam sampling is given in a Symposium on Problems and Practice in Determining Steam Purity by Conductivity Methods. Proceedings ASTM, Philadelphia, Pa. Vol. 41, 1941, pp. 1261-1340.*

If there is enough interest among Q & A readers in the apparatus and methods used for obtaining water and steam samples, we shall be glad to present more details of the equipment referred to above.

Answer No. 239

Where Does the Engine Get All the Btu's?

AS WE HAVE said before, J. D. G. certainly started something when he asked in the October issue where all the heat units come from that drive his engine. He said it consumed 40 lb of steam per kwhr, that the throttle steam was at 125 psi gage (that's very close to 140 psi abs) containing 1193 Btu per lb and exhaust at 5.2 psi (20 psi abs) containing 1156 Btu per lb, hence the engine took only 37 Btu out of each pound of steam and $40 \times 37 = 1480$ Btu—but there's 3413 Btu in a kwhr! Where do the other Btu's come from, he asked.

It was, of course, obvious that he did not understand clearly the action of steam expanding in an engine. The steam, as so many readers have pointed out, would have 1156 Btu per lb left in it at exhaust if it were dry saturated. But it is not. To furnish the required Btu to make the kwhr and also overcome losses, the steam has to expand in such a way that a small portion of it condenses back into moisture. And it is from the enthalpy of evaporation of that moisture, given up when part of the steam turns back to moisture, that we get the additional Btu's required.

Now all these things were clearly brought out in the comments on this question published in November and December. However, in reading these comments, it has seemed to us that in calculating the numerical answers and explaining the use of the Mollier diagram in solving such problems, some of the comments still failed to analyze the problem correctly. They showed how to plot the adiabatic expansion line on the diagram beginning at the intersection of the 140 psi constant pressure line with the saturation line, at 1193 Btu, then going vertically down and intersecting the 20 psi pressure line at 1049 Btu and 11.1 per cent moisture. Then, some of them reasoned, if the steam expanded adiabatically in the engine under these conditions, it would require only 23.8 lb of steam to make a kwhr. But the engine actually uses 40 lb, so the remaining 16.2 lb of steam must be giving up enough heat to

The 1944 Outlook on STEEL VALVES

A frank statement of the problems facing steel valve users

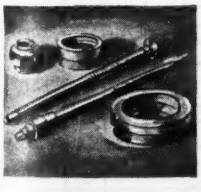
If you have tried to buy steel valves during the past year you know that they have been among the most critical common components in American war production. Is there any relief in sight? How long will shipments take? Will repair parts be obtainable in 1944? *Here are the facts . . . .*

YOU CAN HELP SPEED DELIVERIES. Steel valve production has increased substantially in 1943, but in general has still lagged behind the extremely high demands of the war program. For at least the first part of 1944 this situation is likely to continue. There are, however, several things you can do to speed delivery of the steel valves you will need . . . .

*1. **Stick to standard valves.*** "Specials" slow down production, create order handling delays, and increase possibility that your order may not be filled since they usually require non-standard and short-run parts hard to obtain or manufacture.

*2. **See if a substitute is available.*** Often the exact type of valve you order may be oversold. In many cases a substitute valve type which will do the job as well will be available on a shorter delivery schedule.

*3. **Check your order.*** With steel valves, as with other critical war products, many delivery delays have had nothing to do with production. They have resulted from failure of the purchaser to furnish on the original order complete priority information, product description or service requirements.



WHAT ABOUT REPAIR PARTS? Requirements for maintenance and repair parts are naturally at a very high level as old equipment is stretched for long periods under extraordinarily heavy loads.

When a valve user orders a repair part he usually needs it in a hurry, and so we have given preferred treatment to repair part orders. Within the limitations of government regulations we will continue to emphasize prompt filling of repair part orders. Out of the great volume of part orders we filled in 1943, less than a handful were ever past due.

WHAT'S HAPPENED TO QUALITY? Today's Edward valves are just as good as they always have been. Recognizing that the service into which war valves go is often tougher than peace-time requirements, Edward has never relaxed material and workmanship standards. Actually there have been few changes in the materials used in Edward valves and in no case has inherent serviceability been reduced.

Nor have expanded operations and manpower losses to the armed forces altered the quality of Edward workmanship, for ours is a veteran organization with a large enough nucleus of thoroughly experienced valve builders to retain our rigid policy of every-stage inspection control with absolute power of rejections.

WHAT'S COOKING? Design development did not stop with the war. Edward engineering and laboratory departments have carried on an uninterrupted program of design refinement. Instead of withholding the results of this development program for a post-war splurge, each improved design—as soon as its value has been proved beyond question—was adopted as Edward standard practice in all cases where war production would not be jeopardized by such change.

Additional types of Edward valves will soon be available, probably before the end of the war. You can expect an announcement in the near future.

For as long as the war continues, the Edward plant will devote its facilities to the kind of on-schedule production that has won the Victory Fleet Flag, the Maritime "M" pennant, and an additional Gold Star, without prejudice to the service and planning needs of purely peace-time customers. And when V-day comes, the Edward plant will be ready.

W. F. Crawford
President

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overcome the engine and generator losses.

It seems to us that there are several fallacies in this reasoning. In the first place, we know that the engine cannot be a perfect engine, therefore it is impossible for a part of the steam to expand as if it were a perfect engine and the remainder to expand in some other way. In the second place, for an accurate determination of the actual expansion, you must know either the enthalpy of the exhaust steam or the quality. Knowing one, from $h = g + XL$ you can find the other. But either quantity must be measured or assumed.

Now any assumption of h must be based on either a knowledge or an assumption of engine and generator losses. And if you assume these too high, your engine has a higher Rankine cycle efficiency!

It seems to us that the only correct analysis is (1) that every pound of steam expands at something less than the full adiabatic expansion, hence each pound of the steam gives up less heat than if perfect adiabatic expansion occurred, hence the enthalpy of the steam at exhaust must be less than in a perfect engine and (2) consequently the moisture in the steam must be lower than it would be with ideal adiabatic or isentropic expansion. However, since $3413 \div 40 = 85$ Btu and $1193 - 85 = 1108$ Btu, the exhaust enthalpy must be somewhere between 1108 and 1049 Btu because the 85 Btu would only just generate the kwhr. The quality also would have to be somewhere between 6 and 11 per cent.

In short, it seems to us that, although most of the comments correctly point out the source of the missing Btu's, many of them calculate the amount incorrectly by using the perfect adiabatic expansion line on the Mollier diagram as the actual expansion line. It seems to us that Julian P. Calvert's analysis in the December issue is much closer to the actual situation and that the answer given below from F. C. De Weese is the clearest explanation. The section of the Mollier diagram submitted by Mr. De Weese shows what seems to us the true situation and we think his estimate of the losses and of the quality of the exhaust is quite reasonable.

As stated, the only really correct method is to measure the quality of the exhaust with a calorimeter. In doing this, it must be remembered that the throttling calorimeter should be used only within the limits it is designed for.

We have commented at length on this because the principles of the expansion of steam and the use of the Mollier diagram in connection with them are absolutely fundamental in the understanding of the steam engine and, even more important today, of the steam turbine.

Finally, we present a mathematical proof by Mr. Michel of the real source of the missing Btu's. This is really very logical and simple, involving only elementary mathematics, so don't let it scare you. It really gets down to the fundamental energy relations.

How It Looks on the Mollier Diagram

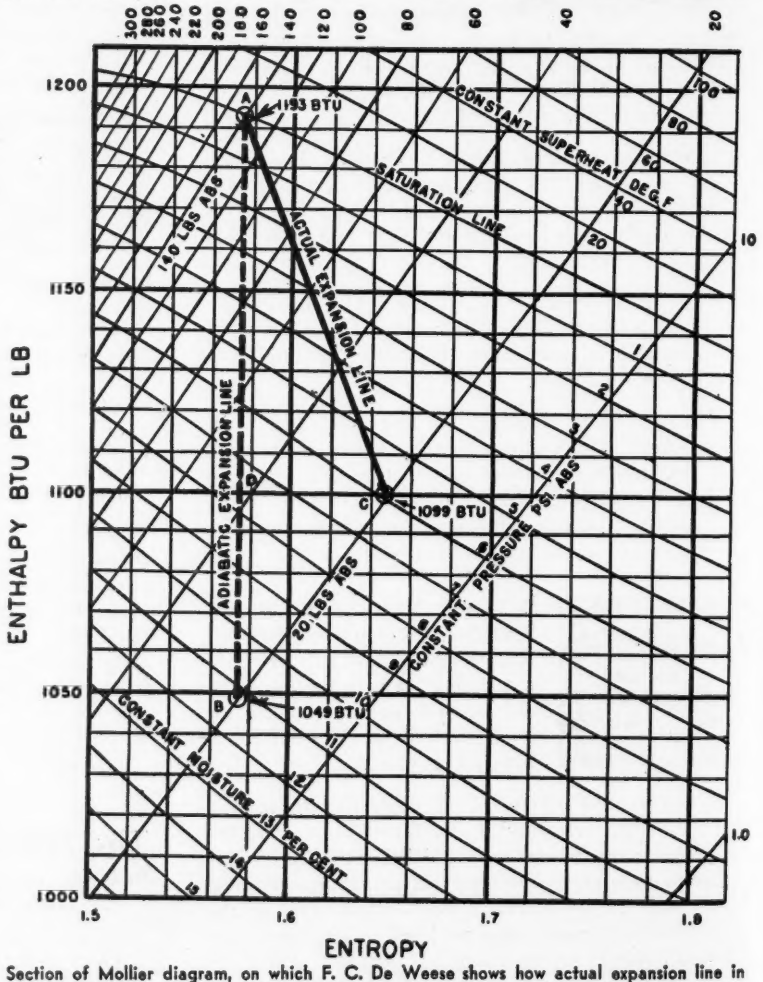
IN THE NOVEMBER issue, Mr. Stromberg has arrived, analytically, at the correct answer to the question propounded by J. D. G.; however, the writer believes a better understanding will be had if we show, graphically, along with a nontechnical discussion, what takes place in his engine cylinder.

Commenting on Mr. Heidecker's solution, I think we can discount the idea of superheat, for two reasons: (a) J. D. G. gives a value of 1193 Btu in the steam at the throttle, which, of course, would be incorrect for superheated steam at 125 psi. (b) The water rate of 40 lb per kwhr is just about what we would expect the performance of a good engine to be when operating under the given conditions.

Referring to the accompanying section of the Mollier diagram, if we were able to pass the steam through the cylinder and let it expand from throttle pressure of 125 psi at A (140 psi abs) to exhaust pressure of 5.2 psi at B (20 psi abs), with no losses in the cylinder, the expansion would be represented by the vertical line A-B, under which condition the engine would utilize all of the available heat in the steam in the given pressure range, this available heat is $1193 - 1049 = 144$ Btu per lb. This would represent 100 per cent efficiency, or an ideal engine, in which the theoretical water rate equals $3413/144 = 23.7$ lb per kwhr.

For every Btu delivered at the switchboard in the form of electrical energy, it will require at least 1.1 Btu at the engine throttle in the form of heat energy. This is just another way of saying that the mechanical-electrical efficiency of the engine-generator set is in the order of 90 per cent. To make up for the loss plus the delivered energy will require that $1.1 \times 3413 = 3754$ Btu of heat energy be converted into work in the engine cylinder for each 3413 Btu of electrical energy (kwhr) produced. Since the water rate is 40 lb per kwhr, we have $3754/40 = 94$ Btu per lb steam actually converted into work.

Since the exhaust pressure remains constant at 5.2 psi, gage (20 psi abs) the heat required to make up for the losses in the ideal engine is $144 - 94 = 50$ Btu per lb, represented by the vertical line D-B. Obviously, as the heat of 144 Btu per lb steam converted into work at 23.7 lb per kwhr is reduced to 94 Btu and 40 lb per kwhr is the actual figure, the point of exhaust will move along the constant pressure line from B to C, where we have $1193 - 94 = 1099$ Btu per lb in the exhaust steam. The expansion will



Section of Mollier diagram, on which F. C. De Weese shows how actual expansion line in engine differs from theoretical line. Reprinted by permission from Thermodynamic Properties of Steam by Keenan and Keyes. Published by John Wiley & Sons, Inc.

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now be represented by the line A-C. The expansion line is not generally a straight line, but for our purpose we may assume it to be so. It should be noted that the quality of the steam at exhaust is indicated to be in the order of 94.2 per cent, which checks closely with the value derived by Mr. Stromberg and the editor.

The internal efficiency of the engine, based on the assumed conditions, 94/144 × 100 = 65.27 per cent. The overall efficiency = 23.7/40 × 100 = 59.25 per cent. The input of 110 per cent is no doubt somewhat lower than would be obtained in the engine, but was assumed to facilitate the calculations.

Raleigh, N. C. F. C. DEWEESE

The Exhaust Is Wet, Not Dry

J. D. G.'s FIGURE of 1193 Btu per lb of steam at 125 psi gage is for dry saturated steam, as is also his figure of 1156 Btu per lb of steam at 5.2 psi gage. Assuming that the steam entering the engine is dry saturated, the steam at the exhaust could not be dry saturated and would contain something less than 1156 Btu per lb.

Briefly, the reasons for this are as follows: When the steam enters the clearance space in the cylinder, it comes in contact with surfaces that were cooled by the exhaust of the preceding cycle. Part of the steam is immediately condensed on the cylinder walls. As the piston is pushed by the steam, more cylinder wall area is exposed to the steam and more steam is condensed. The steam in the cylinder is not dry saturated steam; it now contains water and is known as quality steam. After cutoff, the temperature of the steam may, due to expansion, fall below that of the cylinder walls and some re-evaporation may take place. The quality steam exhausted from the cylinder besides having given up the amount of heat involved in coming down from 125 psi to 5.2 psi has also given up the heat of evaporation for perhaps as high as 40 per cent, by weight, and is therefore known as 60 per cent quality steam. At 5.2 psi gage, 60 per cent quality steam has a heat content of 772 Btu per lb. Using this figure we find that it requires 40 (1193 — 772) or 16,840 Btu to produce 1 kwhr.

Actually, we have not sufficient data to tell us the quality of the exhaust steam. This can best be determined by use of a throttling calorimeter in the exhaust steam line.

Superheated steam of sufficient degree will prevent condensation in the cylinder and will therefore give better economy than dry saturated steam.

CHARLES E. DAY, JR.

Linthicum Heights, Md.

EDITOR'S NOTE—*Mr. Day's value of 60 per cent for the quality of the exhaust seems extremely low and the resulting value of 16,840 Btu per kwhr extremely high—in fact, considering the fact that the ideal expansion line on the Mollier diagram gives only 144 Btu per lb of available heat, it is difficult to see how 60 per cent quality steam could be obtained. As Mr. Day says, however, the best determination is by a calorimeter on the exhaust line.*

Clark Shows How to Figure Back from Assumed Efficiency

OVERALL EFFICIENCY, E, of the engine generator, set in J. D. G.'s problem, can be expressed as follows:

$$E = \frac{K}{W\,[(h_1 + q_1L_1) - (h_2 + q_2L_2)]}$$

where K = heat equivalent of one kwhr
W = lb of steam per kwhr
h_1 = heat of liquid at inlet conditions
q_1 = quality of steam at inlet conditions
L_1 = latent heat of evaporation at inlet conditions
h_2, q_2, L_2 = same as h_1, q_1, L_1 except at exhaust steam conditions

If the efficiency is taken at 80 per cent and moisture in inlet steam at 2 per cent, the quality of exhaust steam (q_2) can be calculated as follows using values from Keenan and Keyes Steam Tables, 1932:

$$0.8 = \frac{3411.5}{40\,\{[324.56 + (867.8 \times .98)] - [195.8 + (q_2 \times 960.1)]\}}$$

$$q_2 = \frac{1174.9 - 195.8 - 106.6}{960.1} = 0.908 \text{ or } 90.8 \text{ per cent}$$

Thus, for the stated conditions, each pound of steam gives up 106.6 Btu in the engine and the exhaust steam contains 9.2 per cent moisture. This explains where the apparently additional Btu's come from. Total heat of inlet steam is 1174.9 and exhaust steam 1068.3 Btu per lb.

St. John, N.B., Canada C. G. CLARK

Michel Shows Where the Additional Btu's Really Come From

The following equation appears on Page 3-72 of Kent's Mechanical Engineers Handbook, Vol. II, Power, 11th Edition. (John Wiley & Sons, Inc.)

$$E_m = h_1 - h_2 + Q_h + \frac{V_1^2 - V_2^2}{778.6 \times 2g} + \frac{Z_1 - Z_2}{778.6} - Q_e$$

This equation is a statement of the energy obtained from any heat engine, such as a steam engine or steam turbine, where:

E_m = Energy obtained, Btu per lb.
h_1 = Total Enthalpy or total heat in the steam (in our case) at some initial point (at the throttle).
h_2 = Enthalpy or total heat at some second point (at the exhaust).
Q_h = The heat in Btu per lb gained from any outside source such as a hot water jacket, or it may have a minus sign and represent the heat removed by a cooling water jacket.
V_1 = The velocity of the steam at the initial point in ft per sec.
V_2 = The velocity of the steam at second point in ft per sec.
g = Acceleration due to the force of gravity = 32 ft per sec.
Z_1 = The head of steam above a chosen ground or datum line at the initial point, in feet.
Z_2 = The head of steam above a chosen ground or datum line at the second point, in feet.
Q_e = The heat lost by radiation, leakage, etc. Btu per lb.

The number 778.6 is a conversion factor to change ft-lbs into Btu per lb.

Thus we have four and only four sources of energy in a steam engine and one way in which energy may be lost.

These are as follows:

(1) $h_1 - h_2$ Energy coming from expansion or loss of heat of the steam.

(2) Q_h Energy coming from some outside source.

(3) $\frac{V_1^2 - V_2^2}{778.6 \times 2g}$ Energy coming from loss in velocity of the steam between the first and second point.

(4) $\frac{Z_1 - Z_2}{778.6}$ Energy coming from the difference in pressure of the steam between the first and second points.

(5) Q_e Heat lost due to leakage, radiation, etc. Therefore it is not a source of energy.

Term (3) we call kinetic energy. Term (4) we call potential energy. Term (4) is not to be confused with the Term (1). They are not the same source of energy at all.

J. D. G. calculated the energy obtained from his steam engine by using the Term (1) only. In other words he said:

$E_m = h_1 - h_2$
$E_m = 1193 - 1156 = 37$ Btu per lb

J. D. G. cannot be blamed too much for calculating it this way because most handbooks and textbooks state that the (3) and (4) terms are negligibly small, except in certain cases where they have to be considered. Evidently J. D. G.'s case is one of those exceptions for we find that he cannot account for an extra 48.3 Btu per lb.

Calculations:

3415 = Btu per kwhr
40 = lb steam/kwhr (J. D. G. is using)

$\frac{3415}{40}$ = 85.3 Btu per lb of steam (J. D. G. is getting according to his watt-meter)

85.3 — 37 = 48.3 Btu per lb of steam that is coming from some other source.

The added energy cannot be coming from the Term (2) because I'm sure that if J. D. G. had a hot-water-jacketed engine he would have said so and recognized himself that it was a source of energy.

This leaves us with but two energy source terms left—(3) and (4). The problem now is to determine from which

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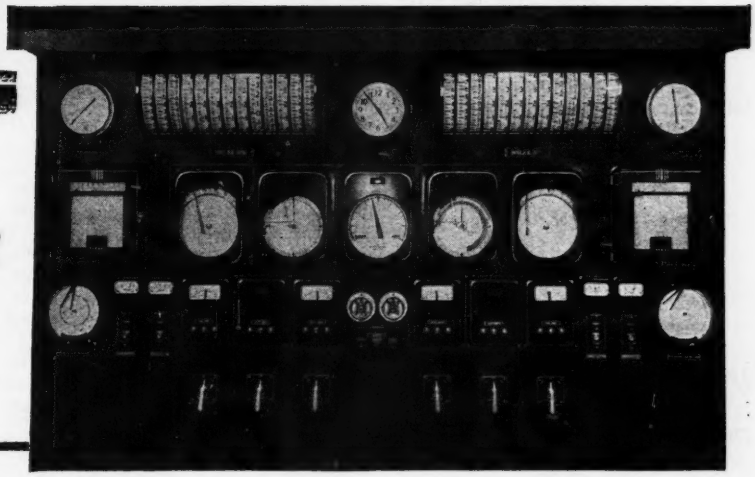

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of these sources the added energy is coming.

Let us now calculate the added energy it is possible to obtain from each of these terms.

First we will take the third (3) term

$$\frac{V_1^2 - V_2^2}{778.6 \times 2_x}$$

From the study of hydrodynamics we know that:

$V_1 = \sqrt{2gh_1}$ and $V_2 = \sqrt{2gh_2}$

Where:

V = Velocity in ft per sec.

g = Force of gravity

h = Head of fluid in ft

Also:

$$h = \frac{P}{w}$$

Where:

p = pressure (gage) in lb per sq ft.

w = weight of fluid in lb per cu ft.

then substituting values from data given in problem

$$h_1 = \frac{125 \times 144}{0.3109}$$

144 = conversion factor of psi to lb per sq ft; value 0.3109 taken from Kent's Mech. Engr's Handbook, Loc. Cit.

$h_1 = 57{,}800$ ft

$V_1 = \sqrt{2gh} = \sqrt{57{,}800 \times 2g}$

$V_1^2 = 57{,}800 \times 2g$

$$h_2 = \frac{5.2 \times 144}{0.04976} = 15{,}030 \text{ ft}$$

$V_2 = \sqrt{15{,}030 \times 2g}$

$V_2^2 = 15{,}030 \times 2g$

Therefore:

$$\frac{V_1^2 - V_2^2}{778.6 \times 2g} = \frac{57{,}800 \times 2g - 15030 \times 2g}{778.6 \times 2g}$$

Cancelling out (2g)

$$= \frac{57800 - 15030}{778.6} = \frac{42{,}770}{778.6} = 55 \text{ Btu per lb}$$

Let us take term (4).

Z = h by definition (Don't confuse "h," which is heat term with "h" which is a length or distance term)

and $h_1 = 57{,}800$

$h_2 = 15{,}030$ as determined above.

Therefore:

$$\frac{Z_1 - Z_2}{778.6} = \frac{57{,}800 - 15{,}030}{778.6}$$

$$= \frac{42{,}770}{778.6} = 55 \text{ Btu per lb}$$

So we find, as we should expect, that term (3) = term (4). Potential energy is changed into kinetic energy and, since energy cannot be created or destroyed, the two must be equal.

In my opinion, there is no mathematical or thermodynamic method of proving from which source the energy comes; or if there is one it is beyond my knowledge. However, one may come to a reasonable conclusion as to the correct source, from an ordinary knowledge of steam engines and steam turbines.

In the case of a steam engine, a port opens, allowing steam to enter, then the port closes (being open during only a small part of the cycle). The steam then expands within the cylinder giving up heat and energy to the piston. Then the steam is exhausted. Only while the steam is entering does it have any velocity and then may be considered static when it gets into the cylinder. However, in the instant before it expands it does impart energy because of the difference in pressure between the live steam side of the piston and the exhaust side.

In the case of a steam turbine, the steam comes into the blades from a jet and in this case velocity is very important. The steam impinges against the blades continuously and is always dynamic.

Therefore, I believe that in the case of a steam engine term (4) is the source of energy—

$$\frac{Z_1 - Z_2}{778.6}$$

In the case of a turbine, term (3) is the one to be considered—

$$\frac{V_1^2 - V_2^2}{778.6 \times 2g}$$

As shown above, the energy that it is possible to obtain from term (4) (we shall use the case of a steam engine) is 55 Btu per lb. However, we know that we can account for only 48.3 Btu per lb. This leaves a discrepancy of 6.7 Btu per lb in excess. I think this may be explained when we consider that J.D.G.'s steam engine does not convert all the energy in the steam to kilowatts. He obviously obtained the values 1193 Btu and 1156 Btu from a Mollier diagram, so we are sure they are correct.

If he used 37.1 lb of steam per kwhr instead of 40 lb (leaving him 2.9 lb of steam per kwhr as lost through leakage, radiation, etc. (also mechanical friction) then:

$$\frac{3415}{37.1} = 92 \text{ Btu per lb of steam (at 100 per cent eff.)}$$

And:

$37 + 55 = 92$ Btu per lb of steam

Therefore at 37.1 lb of steam per kwhr the term $\frac{Z_1 - Z_2}{778.6}$ makes up exactly for the added source of energy.

We may also conclude that in the energy equation term (5)

$Q_e = 6.7$ Btu per lb of steam.

So we may say:

$$E_m = h_1 - h_2 + \frac{Z_1 - Z_2}{778.6} - Q_e$$

is the equation J. D. G. should have used.

$E_m = 1193 - 1156 + 55 - 6.7 = 85.3$ Btu per lb

$85.3 \times 40 = 3415$ Btu per kwhr.

If J. D. G. wanted to figure his mechanical efficiency:

$$100 \times \frac{37.1}{40} = 92.8 \text{ per cent}$$

Conclusion: J. D. G.'s "additional Btu's" is energy obtained from the potential energy of the steam or, in other words, from the fact that there is a difference in pressure and exhaust side of the piston during the time the steam is entering the cylinder.

Akron, Ohio — G. L. MICHEL

Answer No. 240

Comments Wanted on This Oil-to-Stoker Conversion

IN THE NOVEMBER issue, R. W. presented a sketch of the method proposed to convert an oil-fired 600-hp longitudinal drum boiler, with two drums and set in battery, to coal firing with a twin-retort underfeed stoker. One feature of the proposed scheme was a motor-driven forced draft blower, set in the space just behind the budge wall, under the rear of the boiler and inside the rear boiler wall. This was done, said R. W., because of lack of space around the boiler but he didn't feel it was a good place for a motor-driven fan and disapproved the idea. He asked for comments on this and other features.

Martin Would Move Fan to Inlet Opening

I WOULD suggest that R.W. install the motor right in the setting where it says "grill for fan inlet" and have the fan and motor shaft run parallel to the boiler drum. The damper opening should have a duct running from the fan frame.

However, that whole rear section behind the bridge wall may be put under forced draft pressure and the opening in bridge wall may be left as shown. If the latter scheme is used, the fan frame should be made rigid and vanes controlling air to the fan may be hooked up to work with the boiler damper—that is, the main damper. Air coming in will keep the motor cool, depending on the temperature of the boiler room.

This method of installing the motor in the setting will protect the motor much more than if it were placed directly inside the boiler. For maintenance and servicing, a small access door should also be built in next to the fan and motor unit.

Fairview, N. J. — MARTIN N. GOZDENOVICH

Use Turbine-Driven Blower Instead of Motor-Driven

AS MANUFACTURERS of forced draft blower equipment, both motor and steam turbine driven, our experience would indicate that placing the proposed blower as shown behind the combustion chamber of the 600 hp water tube boiler, would result in a very unsatisfactory maintenance problem.

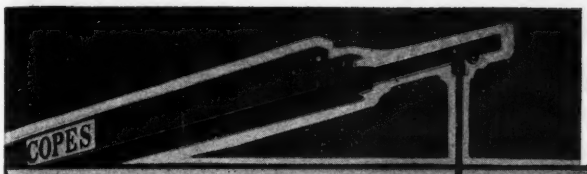
While the boiler is in normal operation, it is conceivable that this space would be well ventilated. If the stokers are shut down for any length of time, however, the temperature would quickly rise to the point where the motor insulation would be baked out and deteriorate.

If R. W. has a space available in his rear boiler wall of approximately 30 in. in diameter and a space behind the boiler of approximately 16 in. to 18 in deep, then possibly our integral steam-turbine-driven blower might prove the answer.

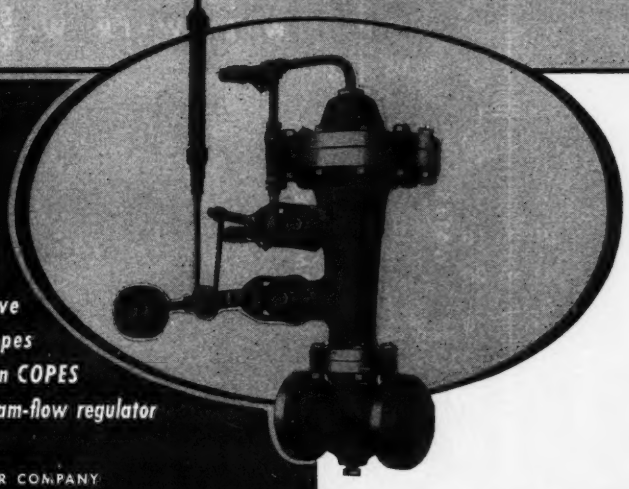
The exhaust steam from these turbine blowers is completely oil-free and can be utilized at back pressures up to 15 psi for either feed-water or plant heating, or for process work.

G. G. NASH

New York — L. J. Wing Mfg. Co.



PAY ONLY FOR MODERNIZATION CONVERT TO FLOWMATIC



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THE cost of converting COPES Simple Level Regulators to Flowmatic, the 2-Element Regulator, has been kept to a minimum through sound basic design. As specialists in boiler feed water systems, it is our aim to make improvements readily adaptable to our thousands of COPES users.

The plants noted at the left are a few that have recently converted to Flowmatic—they paid only for the additional parts and service required.

The simple, sturdy, dependable COPES Regulator can either be made like new again or can be converted into a more modern type COPES unit. The scrap drive will never catch a COPES. If you are an old COPES user you will want to know how to convert to COPES Flowmatic. Write for booklet 429 that tells about Flowmatic, then we can talk about application or conversion.

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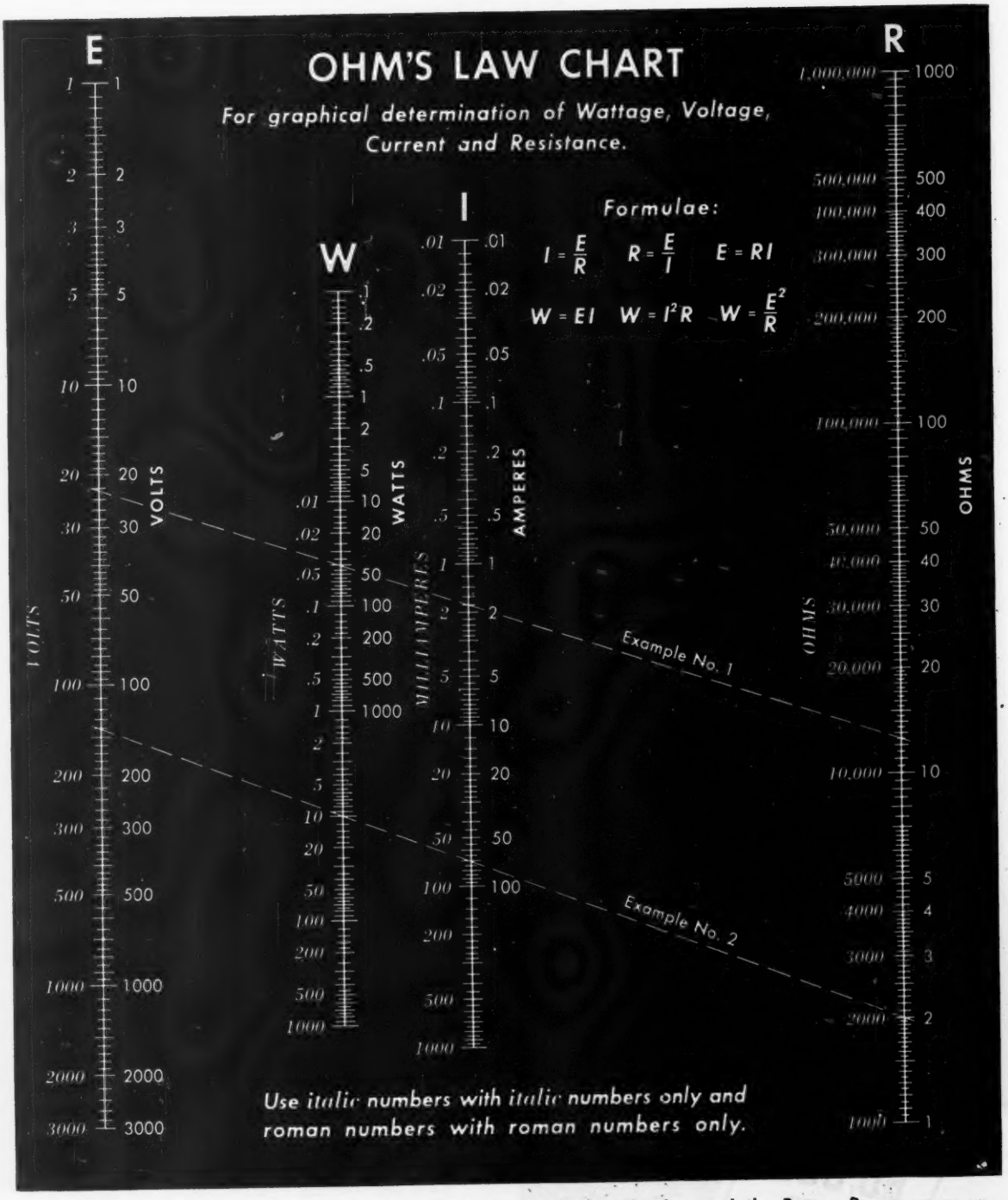

The fundamental law of the electric circuit is Ohm's law which is stated as follows: The current in the circuit is directly proportional to the EMF (Electromotive force) in the circuit and inversely proportional to the resistance.

While the use of Ohm's law is simplicity itself, the chart shown above was designed to permit the graphical solution of Ohm's law problems. It was designed by the engineers of The Ohmite Manufacturing Co. of Chicago, is particularly useful where a large number of resistance problems have to be solved.

It is simple to use. Merely place a ruler across any two known values on the chart and the points at which the ruler crosses the other scales will show the unknown values. The italic figures (on the left of the scales) cover one range of values and the Roman figures cover another range. For a given problem, all values must be read either in the italic numbers or the Roman numbers.

The following examples will show exactly how to use the chart.

Example No. 1: The current through a 12.5 ohm resistor is 1.8 amp. What is the voltage across it? The wattage? Answer: Dotted line No. 1 through R = 12.5 and I = 1.8 shows E to be 22.5 volts and W to be 40.5 watts.

Example No. 2: What is the maximum permissible current through a 10 watt resistor of 2000 Ohm's? Answer: Dotted line No. 2 through W = 10 and R = 2000 shows I to be 70 milliamperes.

SOLNUS OILS

Give Carbon the "Brush-Off"

stop stuck rings and "forced shutdowns"

Bad carbon formations . . . stuck piston rings . . . forced shutdowns were the unwelcome visitors that insisted on making their headquarters in the diesel power plant of a certain eastern factory — until they were ousted by a Sun Oil Engineer and Solnus Oils.

Frequent shutdowns delayed production. Every three to six months carbon had to be removed. At these times the piston rings were so stuck that it was necessary to break them free . . . all this despite the fact they were using a supposedly high grade lubricating oil. So they called a Sun Engineer for advice. After studying the operating conditions he recommended Solnus Oil.

16 months without a shutdown was the record run as soon as the change to Solnus was made. Even then the shutdown was voluntary . . . for routine inspection. It disclosed all rings perfectly free, and what slight carbon there was could be removed easily and quickly with a wire brush.

Plant is now back on schedule and their carbon problem is solved. Solnus Oils may also solve yours. If you want trouble-free diesel performance, investigate these lubricants that are low in carbon content, neutral in acidity, wholly distilled and durable. Write

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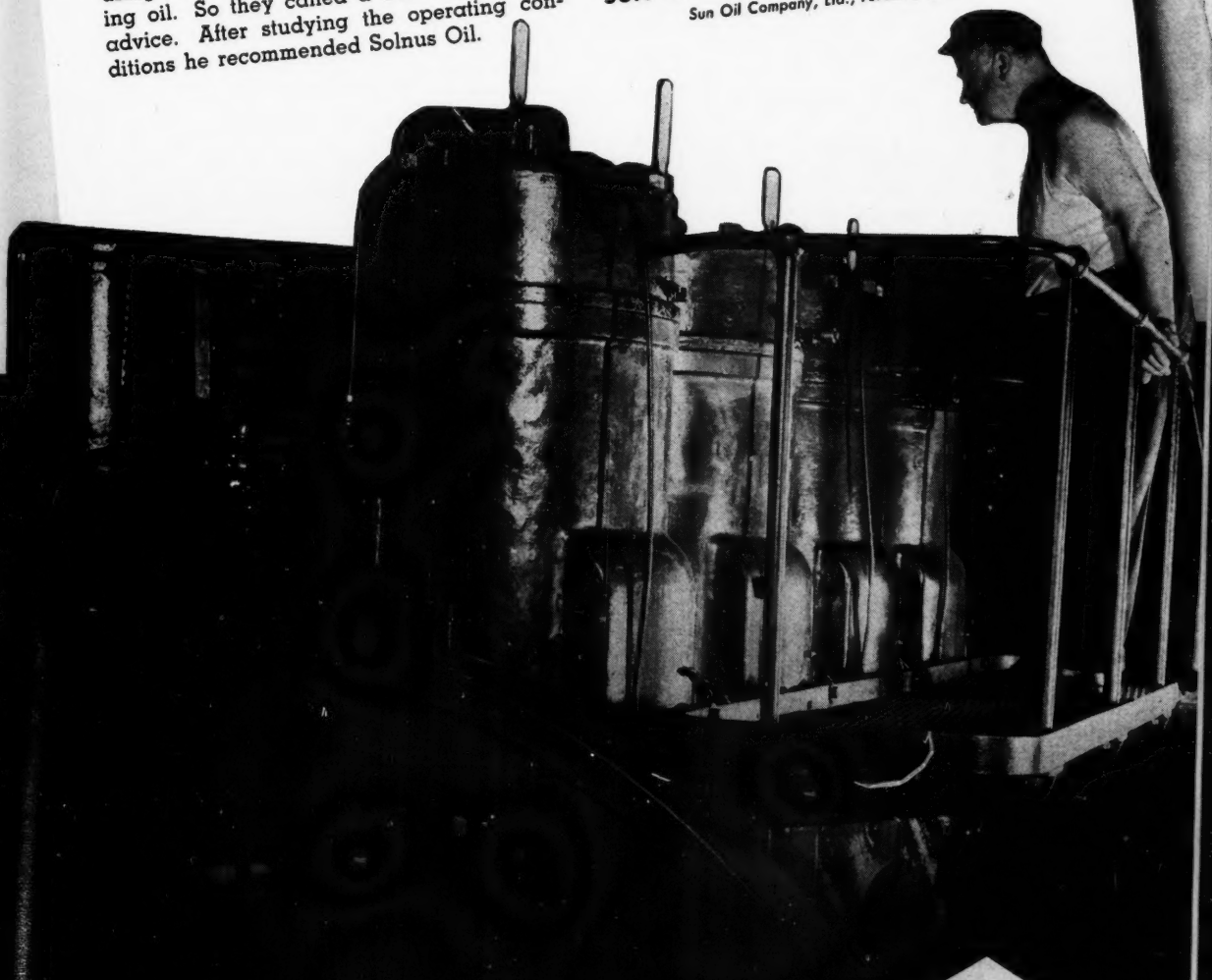

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What Is This Asymmetrical Current and Why Do We Bother with It?

(*Continued from page* 65)

the short circuit occurs when the voltage wave is passing through zero (X) the maximum asymmetry occurs and the first loop of the cycle (M on Fig. 2A) will be very much greater than the second loop (N on Fig. 2A). If the short occurs at the maximum of the voltage loop (Z) then the short circuit current will be symmetrical (Fig. 2B). These are the extremes and a short occurring anywhere between these points will have intermediate degrees of asymmetry. The total height of the short circuit current wave is the same, top to bottom, whether symmetrical or asymmetrical, while the magnitude of the current is determined by the part above or below the zero line. We can see, therefore, that the asymmetrical current under the worst conditions, since its height is all on one side of the zero line, will be initially twice as great as the symmetrical which divides 50-50 above and below the zero line.

This asymmetry of the current wave disappears after a few cycles and the current wave becomes symmetrical, as at L, Fig. 2A. But many interrupting devices open so fast on the occurrence of a short circuit that they interrupt the current during these first few asymmetrical cycles and must, therefore, be capable of opening the high asymmetrical current.

Two other terms are used in the same breath with "asymmetrical current"—"d-c component" and "offset current". Just remember that offset current is only another way of expressing asymmetrical current and that the d-c component is the result of the operating condition of an a-c system under short circuit conditions which introduces a non-alternating current component and causes the asymmetrical current (see Fig. 2A). For the present we need not bother how.

So that's what the engineers mean when they write about "asymmetrical current", "d-c component" and "offset current", and there's no mystery about it. And we "bother about" this asymmetrical short circuit current because it is so much larger than the symmetrical and it places a much more severe duty on the interrupting device. It makes the job of interrupting the circuit much harder and produces a greater magnetic stress which the interrupting device must withstand without damage.

We need know no more about these terms than that given here in order to apply the rules for calculating the short circuit current that some particular circuit breaker or fuse must interrupt on some specific circuit. We just obtain the symmetrical current in accordance with the rules laid down and multiply this by one of the few factors established and published for obtaining asymmetrical current depending upon the type of interrupting device used.

BENJAMIN FRANKLIN and ELECTRICITY

The occasion of Benjamin Franklin's 238th birthday anniversary recalls to mind his leadership in the field of electrical research in his day . . . Originated many present-day electrical terms . . . Discovered nature of lightning . . . First to explain the Leyden jar, forerunner of the modern capacitor

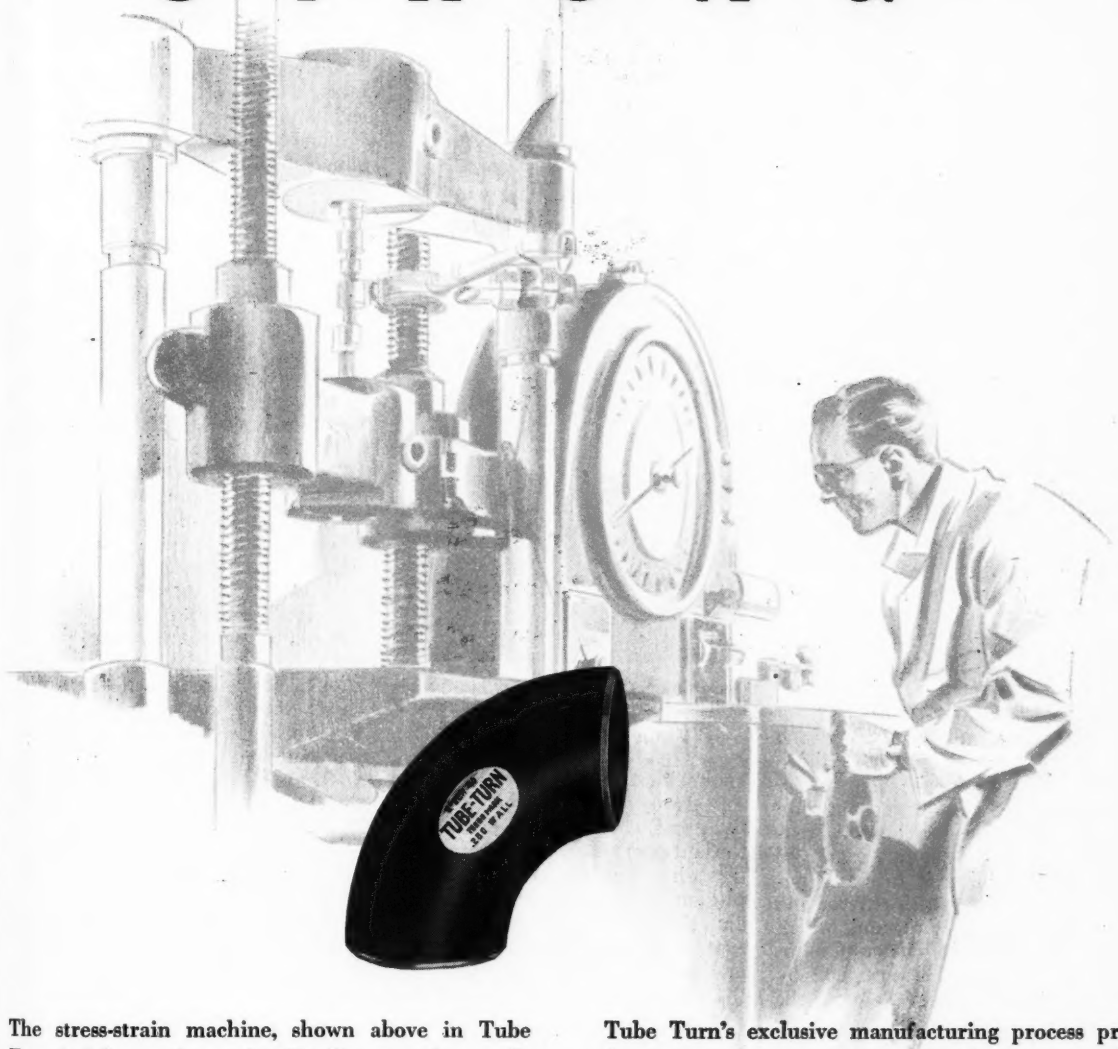
JANUARY 17 marks the 238th anniversary of Benjamin Franklin's birth. Although there is no reason for calling attention to Franklin's birthday this year any more than in other years, the day furnishes an appropriate occasion to recall the contributions which this remarkable man made in the field with which we are all associated, that is electricity.

Compared to the development of the electrical art at the present time, Franklin's experiments in electricity seem simple but in his own day, he was as far ahead of the common mass in his thinking as the electronic experts in the laboratories of today are ahead of the proverbial man-in-the-street. Franklin was celebrated throughout all Europe as the World's foremost electrician and his book on the subject was in demand in many countries. Even today we still write of electricity in terms introduced in print by Franklin. Used in the electrical sense, probably for the first time, in the inventor's book were words such as armature, battery, brush, charged, condense, conductor, discharge, electrical shock, electrician, electrify, minus, negative, non-conducting, plus, positive, and others.

Franklin's book, entitled "Experiments and Observations on Electricity" was published in several editions and was read and admired in all parts of Europe. He presented his findings for both the layman and the specialist and tried to remove all mystery and obscurity from the subject of electricity. The book was composed of letters and papers extending over a period of 20 yr, during which time Franklin added conclusions and footnotes to his writings to change original theories and explain why he had first been misled. Speaking of the footnoted editions, Franklin said, "In going on with these experiments, how many petty systems do we build, which we soon find ourselves obliged to destroy! If there is no other use discovered for electricity, this, however, is something considerable, that it may help to make vain man humble."

Franklin saw his first electrical demonstration in Boston in 1746 and purchased all the apparatus used by the British experimenter, Dr. Spence, and proceeded in electrical experiments of his own with great interest. The work that he did was soon far ahead of the European discoveries and Franklin stated that he had never before become engaged in any study that so totally engrossed his attention and time as electricity. With great enthusiasm, he described new discoveries that were to him unique, for he had no way of telling what work his predecessors had done. Foremost among the observations was the discovery of the action of points in drawing off and throwing off the electrical fire. In order to perform several experiments Franklin had electrified a cannon ball. When the point of a steel bodkin was brought to within six or eight inches of the cannon ball, it was observed that the ball lost its electrification immediately. The metal point had "drawn off" the "electrical atmosphere" from the iron shot.

STRONG



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Welding fittings *must* be strong. Stronger than pipe. For the greatest strain and vibration occur *at the fittings.* Strength is imperative against the high pressures, extreme velocities and corrosive wear to which fittings are subjected in many piping systems. Strong welding fittings help to hold leakage, breakdowns and consequent repairs to a minimum.

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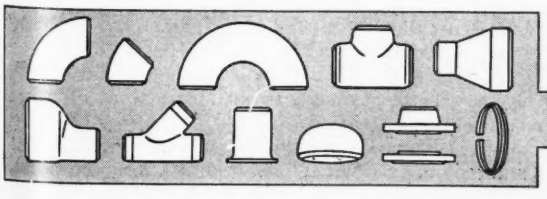

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Leyden Jar Experiment

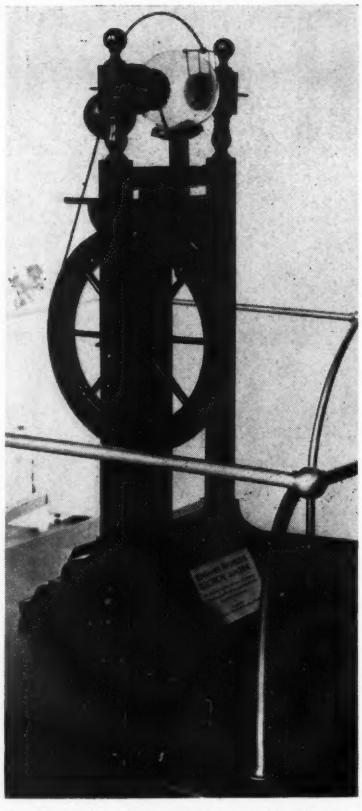
One of Franklin's greatest scientific achievements was his experiment with the Leyden jar which he described fully in his Letter III, to Collinson. He explained the startling discovery that the electrified jar became charged positively on the outside, negatively on the inside. The inventor soon reached the conclusion that electricity was not at all created by friction, but was merely added to or taken from glass by the operation of rubbing. When the Leyden jar became charged, one side gained what the other side lost, in the same amount, and the total quantity of electricity remained the same. Thus Franklin presented the law of conservation of charge for condensers.

Franklin's next discovery was that the charge "resides" in the glass and not in the foil outside or the water inside. The first step was the demonstration that the charge was not in the wire, the cork, or the water, and did not "reside" in the outer coating of lead foil. Next, he showed that the charge "resided" in glass as glass, or, to put it another way, that the charge is in glass because glass is a non-conductor, not because of shape or thickness.

After this, he showed by means of experiment that the positive charge on the outer coating of the jar was exactly equal and opposite to the negative inner charge. Fastening a wire to the outer coating of lead foil, enabling it to stand parallel to the wire which entered the jar through the cork and which was submerged in the water inside, he suspended a cork ball by means of a silk thread between the two wires. Next he placed the jar on a cake of wax so that the outer part would be unable to communicate its electricity to the table or the floor. He observed that every time after he had electrified the jar, the cork ball would "play incessantly from one wire to the other . . . that is, it fetches fire from the top to the bottom (inside to the outside) of the bottle till the equilibrium is restored."

This, according to I. B. Cohen in his book on *Benjamin Franklin's Experiments,* was the first recorded electrical experiment in which a circuit was used in such a way that the electrical "fire" was manifested in other ways than by spark, shock or explosion.

Besides the importance and usefulness of Franklin's discoveries mentioned in his book, the world



Franklin's electrical machine at the Franklin Institute in Philadelphia. This machine is now in storage for the duration

knows him well for his hypothesis concerning the electrical nature of lightning. Up to his discoveries the general impression was that lightning was caused by the explosion of poisonous gases in the air. In 1749, Franklin established that electrical fluid and lightning had similar properties.

The celebrated electrical kite has become a legend and in Letter XI, addressing Peter Collinson, Franklin wrote, "As frequent mention is made in public papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, etc., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner."

After arriving at the conclusion that lightning possessed the properties of electricity, Franklin devised the lightning rod through discoveries about points. He had found that a pointed conductor would discharge an electrified body at a great distance; thus if clouds were electrified, a pointed body would draw electricity from them. Instead of round balls of wood or metal, commonly placed on top of weathercocks, or masts or church spires, he suggested a rod of eight or ten feet in length, sharpened to a needlepoint. This, he felt, would draw electrical fire out of a cloud silently before it could come near enough to strike. At first Franklin did not mention the ground wire, but later mentioned that a wire should run down into the ground outside the object insured. To determine the question whether the clouds that contain lightning were electrified or not, he proposed the following experiment:

"On top of some high tower or steeple place a kind of sentry box . . . big enough to contain a man and an electrical stand (an insulator).

"From the middle of the stand let an iron rod rise and pass bending out of the door, and then upright twenty or thirty feet, pointed very sharp at the end. If the electrical stand be kept clean and dry, a man standing on it when such clouds are passing low might be electrified and afford sparks, the rod drawing fire to him from a cloud. If any danger to the man should be apprehended (though I think there would be none), let him stand on the floor of his box and now and then bring near to the rod the loop of a wire that has one end fastened to the leads, he holding it by a wax handle; so the sparks, if the rod is electrified, will strike from the rod to the wire and not affect him."

The first published account of Franklin's lightning rod appeared in *Poor Richard's Almanac* for 1753.

The rod soon came into use in the United States and in England. In Paris people were interested in learning about American methods of insuring homes against lightning, and Franklin wrote a paper explaining clearly the general principles involved. Franklin sought no profit from his lightning rod, which he refused to patent. His primary aim was only to enlarge the scientific field with a list of important discoveries, which he modestly gave the public, expecting no material reward. His copying machine, stove for burning of pitcoal and consuming all its smoke, arm for taking books down from high shelves, smokeless fire place, woodburning stove, were all some of his inventions for lightening labor which have gone a long way with the development of electricity.

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TO THE VOUGHT CORSAIR

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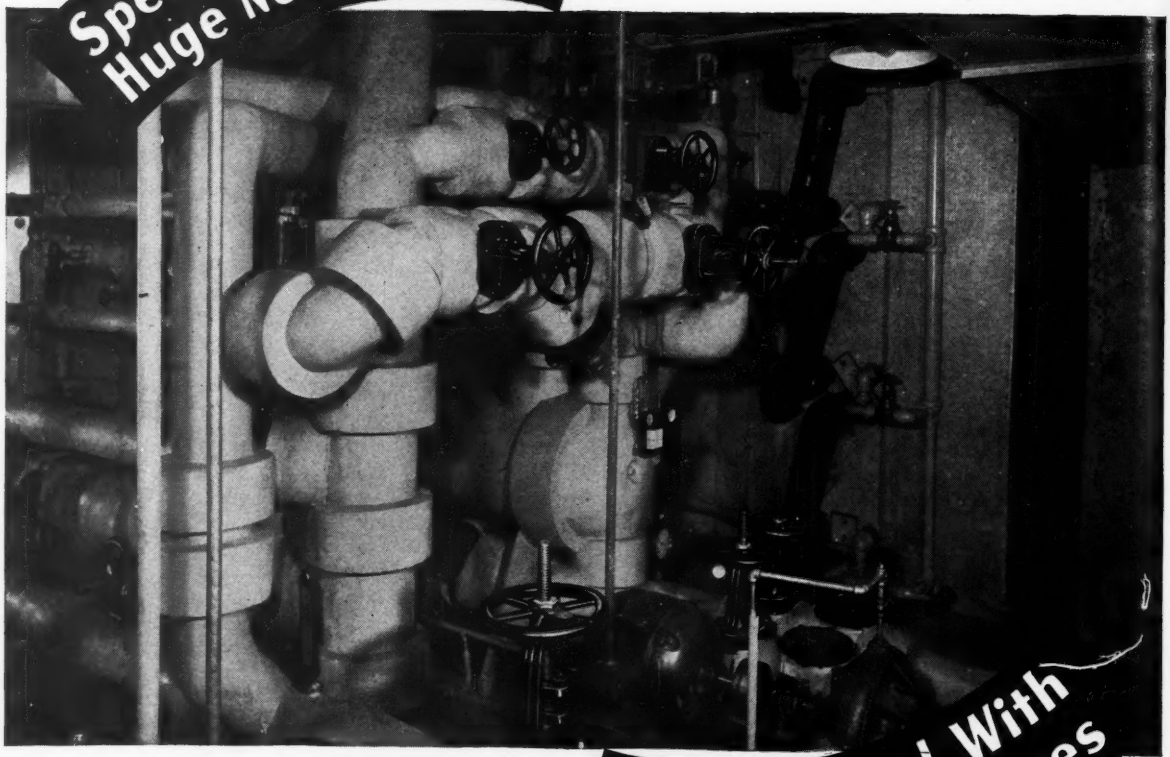

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Reliable and maintenance-free valves are of utmost importance in war plants. No chances can be taken of delays due to valve failure.

Fig. 0405

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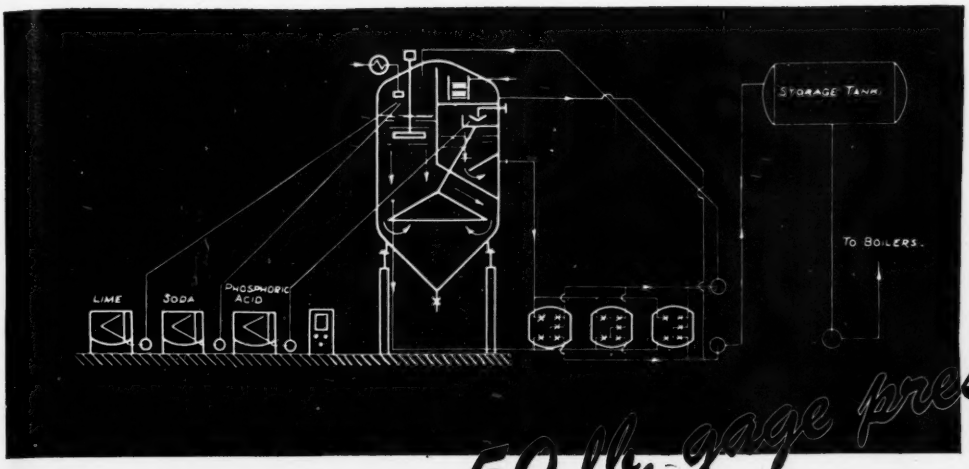


Above is shown the arrangement of Cochrane Hot Process Softener for high pressure, high temperature system.

50 lb. gage pressure

298° F. temperature

COCHRANE HOT PROCESS SOFTENER OPERATING AT HIGH PRESSURE AND HIGH TEMPERATURE IMPROVES PERFORMANCE AND SAVES ON CHEMICALS

THE effectiveness of the hot process softener at high pressures and high temperatures is demonstrated in a recent Cochrane installation.

Whereas most hot process softeners operate at low pressures and seldom over 15 to 20 lb. gage, this softener is operating at 50 lb. gage, with an operating temperature of 298° F.

The chemicals used are lime and soda ash and phosphoric acid.

The installation has a softening capacity of 28,000 g p h of raw water and a capacity to heat and deaerate condensate at a rate of 16,000 g p h.

Softening is carried out in 2 stages. In the first stage the water is treated with lime and soda ash. Then it is decanted to a second compartment where it is deaerated and then treated with phosphoric acid to reduce the hardness and alkalinity remaining after the lime-soda ash process.

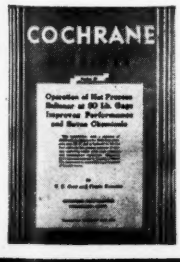
The final effluent is filtered, combined with the condensate and used as boiler feed without further treatment.

This has resulted in a high degree of hardness reduction and in economy of chemicals. Further details of this installation are incorporated in Cochrane Reprint No. 25. Write for a copy.

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia 32, Pa.

AVAILABLE FOR REFERENCE

COCHRANE REPRINT NO. 25



"OPERATION OF HOT PROCESS SOFTENER AT 50 LB. GAGE"

By Joos and Kemmer

A reprint of this story describing in detail the above installation. If interested, this reprint should be of considerable help in solving your own water conditioning problems. Write for a copy Use the coupon →

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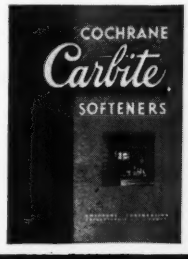

COCHRANE CARBITE (CARBONACEOUS ZEOLITE) SOFTENERS

A 16 page publication describing in considerable detail the Cochrane Carbonaceous Zeolite Softening Equipment, with typical analyses, diagrams and photos of installations. A copy will be mailed on request. →

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COCHRANE

HOT PROCESS SOFTENERS · DEAERATORS · BLOW-OFF SYSTEMS · FLOW METERS · SPECIALTIES

WeldELLS

have everything ★

"You said it, brother—EVERYTHING!"

His job is *welding;* not fooling around getting ready to weld.

He can put more time on actual welding when he uses WeldELLS:*

—Because their tangents make them easier to line up.

—Because their precision quarter-marked ends simplify layout.

—Because the size and thickness are permanently marked on every fitting.

He can turn out a better job, too, when he uses WeldELLS—thanks to their dimensional accuracy and to the machine tool beveled ends that provide an ideal welding surface.

And the features that mean so much to the welder are also vitally important to the men who engineer the job and those who live with it.

★ No other fittings for pipe welding combine these features found in WeldELLS:

- **Seamless** — greater strength and uniformity.
- **Tangents** — keep weld away from zone of highest stress — simplify lining up.
- **Precision quarter-marked ends** — simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking** — saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum** — assures full strength and long life.
- **Machine tool beveled ends** — provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

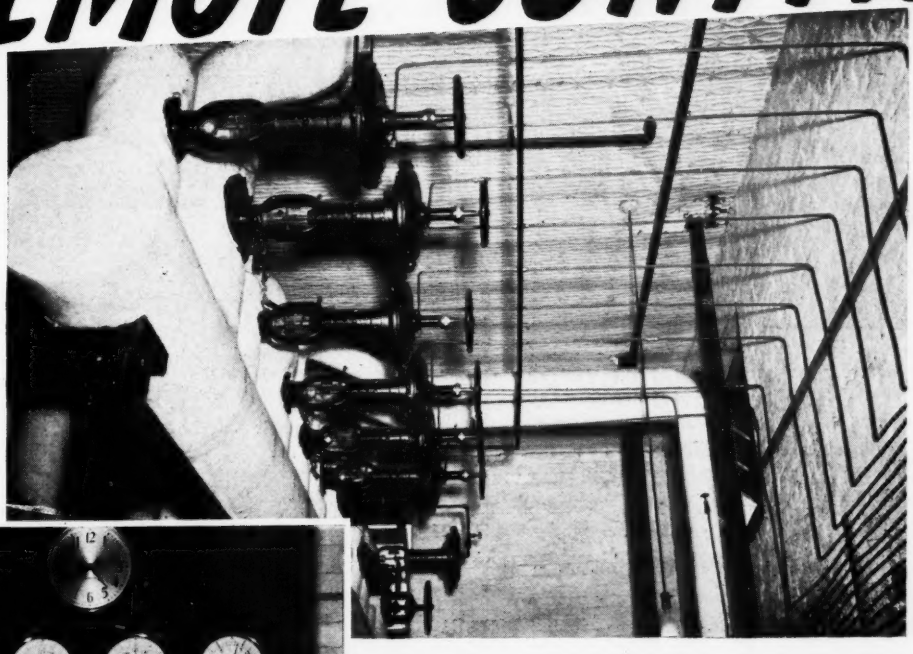
* WeldELLS and many other Taylor Forge products are produced in Byers Genuine Wrought Iron.

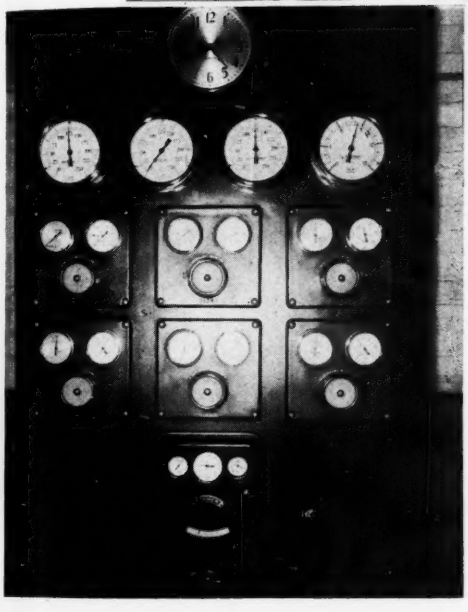
TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485

• The list of Taylor Forge's contributions to the war effort only begins with WeldELLS. One of many examples is Taylor Corrugated Marine Furnaces, essential to many merchant ships and transports.

NEW YORK OFFICE: 50 CHURCH ST. • PHILADELPHIA OFFICE: BROAD ST. STATION BUILDING

REMOTE CONTROL





All Fisher diaphragm motor valves are designed and manufactured particularly for pilot valve actuation. They provide full throttling control and react accurately and promptly in accordance to the dictates of the remote mounted pilots. Complete information about Fisher Diaphragm Motor Valves and Fisher Pilot Valves will be furnished on request.

Our increased manufacturing facilities, plus new and improved methods, resulting from our all out War Effort have greatly stepped up the production of Fisher Automatic Controllers. Consequently, we are now in a better position to invite your inquiries on general industrial automatic control requirements.

STEAM PRESSURES ACCURATELY CONTROLLED BY FISHER DIAPHRAGM VALVES ACTUATED BY PANEL MOUNTED FISHER PILOT VALVES . . .

These modern power plant illustrations show an excellent example of remote control of steam pressures for heating and processing purposes.

The Fisher Diaphragm Motor Valves shown above are installed in the steam lines from the main header, and are actuated by the Fisher Pilot Valves mounted on the panel board illustrated at left. Hand jacks have been supplied for manually positioning or manually closing the inner valves when necessary. This installation gives the operator literal "finger-tip" control of steam pressures to all parts of the plant.

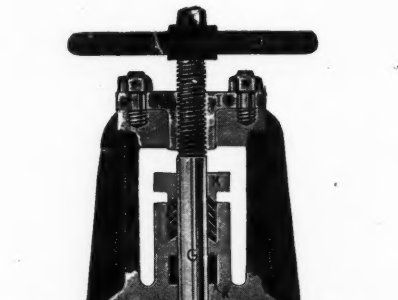
For this service Fisher Diaphragm Motor valves can be furnished with single port bodies for tight shut-off or for normal throttling control they may be equipped with double ported V-Port or Plug type inner valves.

★

FISHER GOVERNOR COMPANY, 1018 FISHER BLDG. MARSHALLTOWN, IOWA

GOLDEN-ANDERSON

Specialty Valves



SINGLE-ACTING NON-RETURN

OPERATING SEQUENCE—Automatically *cuts in a boiler* whenever its pressure equals line-header pressure . . . automatically *isolates a boiler* whenever its pressure from any cause, is less than line-header pressure.

CONSTRUCTION—A "Double Corliss" dashpot assembly effectively cushions the valve . . . prevents banging, chattering or spinning under any flow conditions. This design insures perfect alignment of parts, eliminates binding and assures unfailing automatic operation.

G-A Non-Return Valves are furnished double extra heavy throughout . . . rated as the heaviest valves of their kind, thus there is no distortion or warping under pipe line stress and strain. Trim may be bronze, monel, stainless steel, or Gallavoy, according to pressure and temperature conditions.

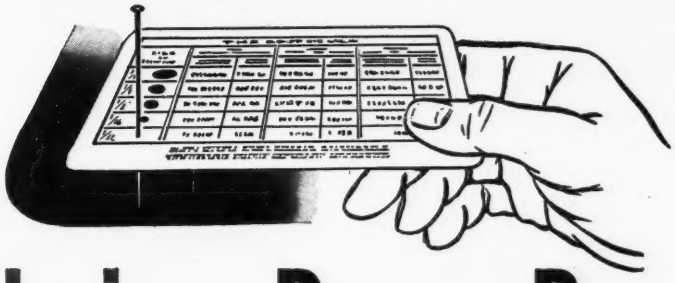
PATTERNS AND SIZES—These valves are available in Angle, Globe, Elbow and Cross patterns . . . sizes 2½" to 12". Larger sizes are available in all series to 1500 lbs. pressure.

The G-A line of Specialty Valves includes Altitude Control . . . Pressure Reducing . . . Throttle and Emergency Stop . . . Check Valves, etc.

Complete description, diagrams and illustrations of this and all other G-A Specialty Valves are given in our latest catalog. Write for it today!

GOLDEN-ANDERSON VALVE SPECIALTY CO.

FULTON BLDG. • • • PITTSBURGH, PA.



How Big is a pinhole in a Power Plant?

Big enough to cause a lot of trouble—when the pinhole is in the seating of a valve that's supposed to be shut off *tight*.

Here's the story in terms of normal pressures:

At 100 lbs. — **STEAM** — 3,175 lbs. wasted per month per valve

At 100 lbs. — **AIR** — 69,552 cu. ft. wasted per month per valve

At 40 lbs. — **WATER** — 4,800 gals. wasted per month per valve

This is just a $\frac{1}{32}$" hole, at normal pressures. A pinhole across the seat of a 1" valve is a leak that might have called for a new valve before the war. In a 16" valve, on the other hand, it may be regarded as "normal seepage."

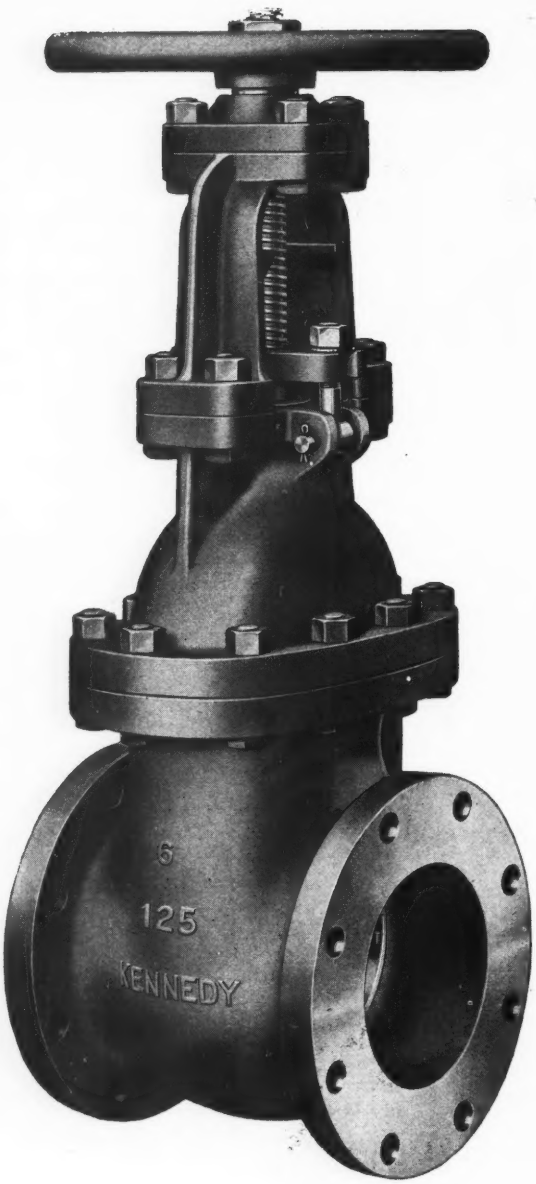
The point is, you can *reseat* ANY globe valve from ¼" to 14"; or ANY gate valve from 1½" to 48"; *without removing it from the line,* and you'll come out with a valve that doesn't leak at all! . . not even "normal seepage!" All you do is remove the bonnet and insert a Dexter Valve Reseating Machine. In a few minutes you have cut a new face on the ports: a face that is true — in fact, better than usually found in a new valve.

There are Dexter outfits specially designed for reseating reciprocating pump valves from 2" to 15".

In most cases a valve can be reseated on the line in less time than would be required for removal and replacement.

Have you any leaky valves? Write us about them — we'll recommend the Dexter Valve Reseating Equipment that will handle your situation economically.

THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS



- **RELIABILITY**
- **STRENGTH**
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- **SAFETY**

. . . characteristics of every **KENNEDY** *valve*

Kennedy Valves are reliable because of their simple, sturdy and effective operating mechanisms. Many of these mechanisms were originated by Kennedy, and have proven their effectiveness in thousands of installations.

These valves are economical because of their durability which has been demonstrated by decades of service in many installations without maintenance expense.

Their generous proportions of all parts, together with high-quality, high-tensile-strength metal, assure ample strength and complete safety. You are always safe with Kennedy "Extra Value" Valves.

THE KENNEDY VALVE MFG. CO.
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KENNEDY valves . . . pipe fittings . . . fire hydrants

WAR PRODUCTION KEPT IN HIGH GEAR...

...by O.S.* in factory turbine

HOW GOOD is the turbine oil you now use, at resisting high temperatures? Air? Water? None of these faze Shell Turbo Oil. For in addition to having *superior oxidation stability*, it also *prevents rust* . . . two of the most vital characteristics a turbine oil must possess in order to give economical, trouble-free performance in today's high-speed turbines.

No wonder Shell Turbo Oil, even after 20,390 hours of continuous operation in the turbine of a leading manufacturer came through with the analyses shown at right. Can the turbine oil you now use match this performance in every respect?

For details on this and other outstanding performances of Shell Turbo Oil see the Shell man. Or, write Shell Oil Company, Inc., Dept. "I", 50 W. 50th St., New York 20, N.Y., or 100 Bush St., San Francisco 6, California.

CERTIFIED PROOF OF THE SUPERIOR

*OXIDATION STABILITY

OF SHELL TURBO OIL

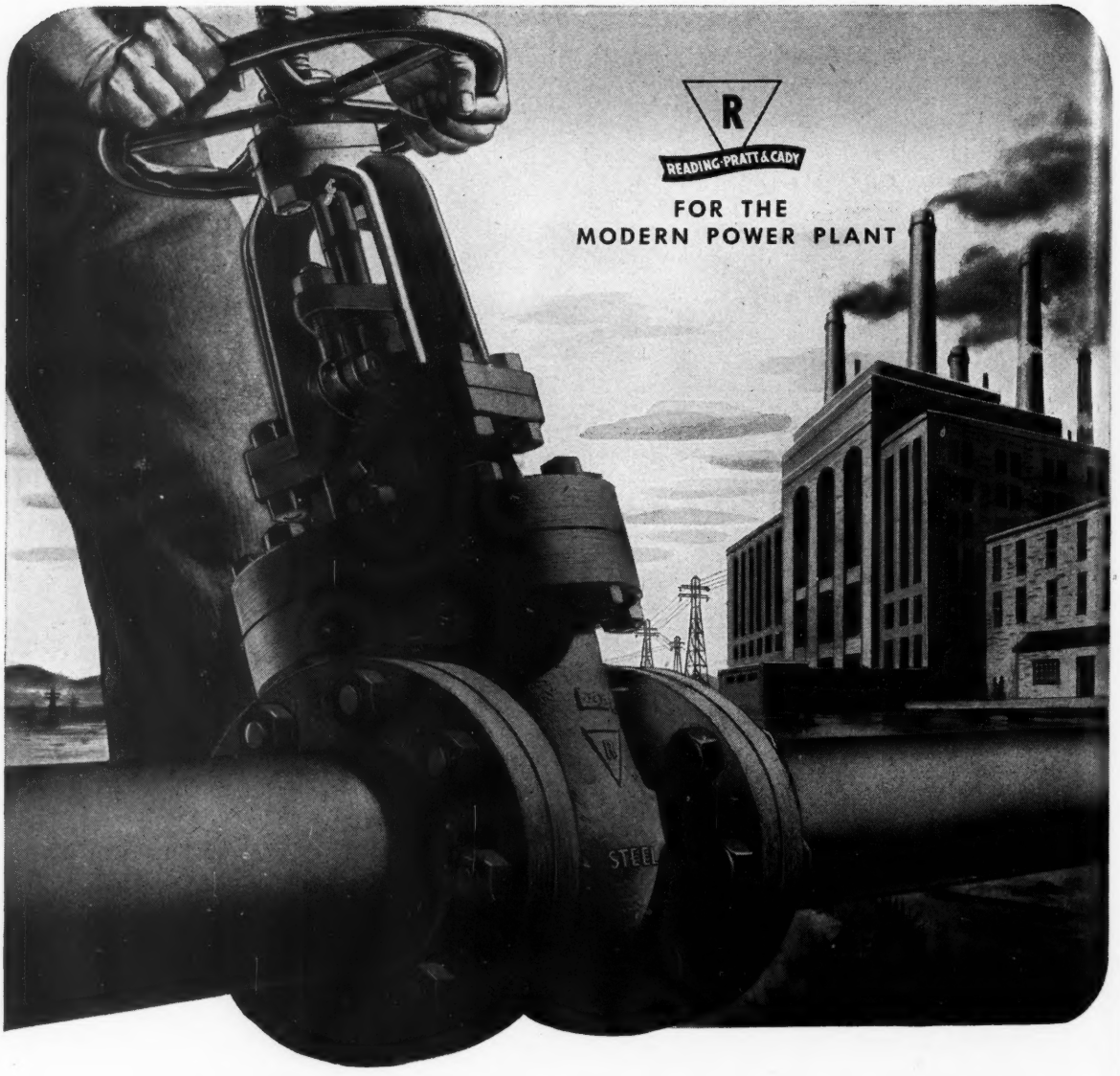
150-170	CHARACTERISTICS	166
Clear	Viscosity @ 100° F.	Clear
.05	Appearance	.05
.1	Neutralization No.	.2
	Saponification No.	

Performance record of Shell Turbo Oil in a 2000 kw. unit of a famous farm machinery manufacturer.

SHELL

SHELL TURBO OIL

Currently, the U.S. Navy has first call on Shell's entire production of marine turbine oil



● A wealth of "know how" and valuable new methods have been fried out by the heat of the most intense production period this organization has known since its first days in 1878. . . . To be sure, most of the valves we have made have gone directly to the war effort. But as soon as the materials pressure upon the Nation and the demand for this production from us ease up, you will find great gains reflected in the very valves we will be producing for you.

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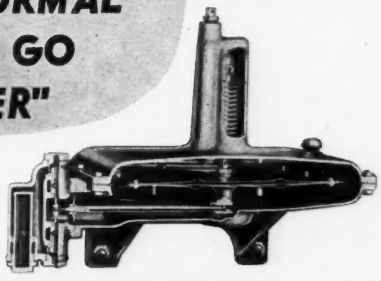
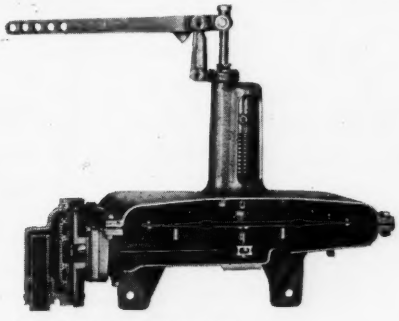
WHAT THE ENGINEER SAID TO THE BOSS!

"NO SIR, WE WON'T REQUIRE MORE FUEL ... WE'LL NOW GET THAT ADDED STEAM CAPACITY BY MAKING OUR NORMAL SUPPLY GO FARTHER"

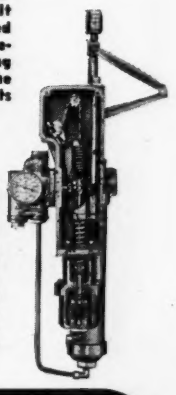
CASH STANDARD AUTOMATIC COMBUSTION CONTROL SYSTEMS



FURNACE DRAFT CONTROLLER
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.



AIR FLOW CONTROLLER
This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER
This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

As soon as CASH STANDARD Automatic Control Systems are installed, engineers make observations important to the boss. They see that the boilers stretch in capacity. That more heat is produced from less fuel. That there is considerable savings in fuel (coal, oil, or gas). That operating efficiency is increased. That attendance time is cut.

It all results because a CASH STANDARD Automatic Combustion Control System makes possible correct fuel feed, proper air supply, and constant over-fire draft in plants as small as 60 h.p or as large as they come.

Bulletin No. 300 gives you full details on applications and operations. Write for a copy.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD CONTROLS .. VALVES

Vogt

for better DROP FORGED STEEL *Fittings*

in SOCKET WELD *and* SCREW END TYPES

SOCKET WELD TYPE

Schedule 40—(Standard)
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Schedule 160 & Double Extra Heavy
Sizes ¼" to 6"

Choose either type with Confidence, when Drop Forged by **VOGT!**

Vogt drop forged material is uniform in structure, fine grained and free from porosity, with a "plus" of strength and toughness that safely withstands the strains and shocks of service at high temperatures and high pressures. Ells, Tees, Crosses, etc., are available in various alloys to meet any of your special service conditions.

WRITE FOR BULLETINS OR ANY SPECIAL INFORMATION

SCREW END TYPE

2000 pound 3000 pound
6000 pound
Sizes ⅛" to 6"

HENRY VOGT MACHINE CO., Incorporated, LOUISVILLE, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

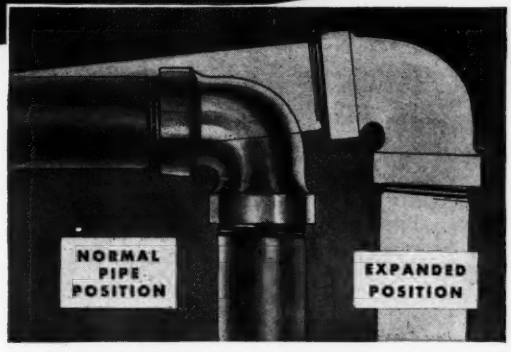
Do You Realize . . .

. . . THAT A LOW PRESSURE STEAM SUPPLY LINE 1000 FT. LONG MAY EXPAND MORE THAN 15" WHEN STEAM IS ON?

. . . THAT A RETURN LINE 1000 FT. LONG MAY EXPAND MORE THAN 10"?

. . . THAT YOU CAN NOT PREVENT IT?

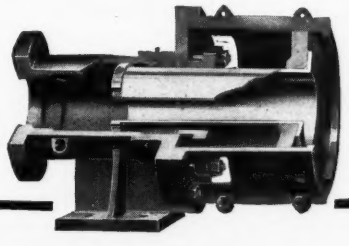
. . . THAT YOU MUST PROVIDE FOR IT?



● **Although there is less expansion in low pressure than in high pressure steam lines, it acts just as surely and provision must be made to take care of it. While the hazard from broken pipe or fittings may be less, it is by no means negligible.**

It is a mistake to spend good money to install a piping system, then impose undue stress on the piping by failing to provide for the inevitable contraction and expansion.

Sound engineering practice and good common sense dictates the wisdom of installing ADSCO Expansion Joints. Simple tables in the ADSCO Catalog, cuts and descriptions show which type is best suited to your needs. Write for catalog 35E or describe your problems and we will be glad to assist you in making a choice.



CONTROL EXPANSION WITH ADSCO INTERNALLY-EXTERNALLY GUIDED EXPANSION JOINTS

This joint meets the Army and Navy specifications for installation on defense projects — thousands now in use. The internal and external guides keep the slip in true alignment, prevent damage to packing or slip. Available in single or double joints for high or low pressure service on steam, hot water, oil, gasoline, gas or process lines.

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N. TONAWANDA, N. Y.
MAKERS OF "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 60 YEARS.

Relative size of ADSCO Expansion Joints and pipe bends for an 8" pipe with 4" expansion. ADSCO Expansion Joints save space — make a more workmanlike job.

ADSCO EXPANSION JOINTS

Eliminates cumbersome pipe bends

WHEN IT'S TOO HOT FOR ORDINARY PIPE

use INSIDLINE

Insidline is an internal insulation and lining to hold the temperature of pressure piping to 650° F., or below, where the phenomenon of "creep" does not occur and metals can be operated indefinitely at usual stress allowances. Thus the use of carbon steel piping, normally specified for a given pressure, is made possible for a wide range of internal temperatures.

At the same time Insidline accomplishes the secondary objective of heat conservation. This can be carried to any degree indicated by the economies or other considerations in a given process.

Because Insidline greatly simplifies the design of pressure piping, and permits the use of ordinary carbon steel piping instead of special, costly, alloy steel, substantial savings result. If you have a hot pipe problem in any diameter from 2" to over 100", it will pay you to check with B-H engineers.

Baldwin-Hill Co., 577 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J., Kalamazoo, Mich., and Huntington, Ind.

Baldwin-Hill

BH COMPANY

HEAT & COLD INSULATIONS

South Meadow's New 40,000 Kw Extension

(*Continued from page* 64)

Highly effective deaeration is obtained by the two open heaters in series and the provision of a heating coil in the 8th stage storage tank that prevents the introduction of highly aerated water into the boiler during refilling operations.

With this system, the effective use of extracted steam and the careful avoidance of degradation of energy results in less than 75 per cent of the throttle flow reaching the condenser, despite the fact that only three stages of extraction are used. Under the conditions indicated on the diagram, Fig. 3, the heat consumption of the turbine at 40,095 kw net output is 9520 Btu per kwhr.

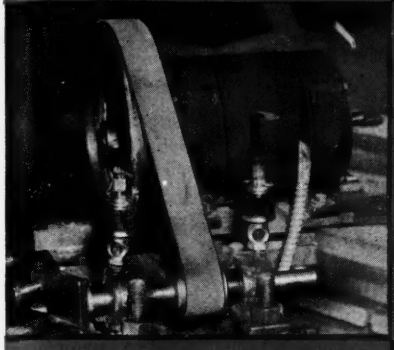
Electrical Features

The most distinctive feature of the 1942 Extension at South Meadow Station is the electrical arrangement of the new generator and associated bus structure. Several circuits out of the station were all ready operating at 22 kv, with individual auto-transformers located just outside of the switchhouse providing the transformation from 11 kv, and additional 22 kv feeders will probably be required in the near future. It was decided, therefore, to supply the entire output of the new machine at 22 kv and to install sufficient 22 kv bus to accommodate six feeders. In order to maintain the existing high standard of service reliability and to provide for complete interchange of capacity, two physically and electrically separate 22 kv main buses with two circuit breakers per position and provision for connection to the existing 11 kv double bus were required.

To accomplish this, three 50,000 kva, 11/22 kv Pyranol immersed and forced Pyranol cooled transformers, suitable for indoor use, were installed. One of these transformers, located in a special room just off the condenser floor, is connected directly to the main 11 kv leads of the new generator and feeds the new 22 kv buses through selector breakers. The other two transformers provide the ties between the two new 22 kv buses and the existing 11 kv double bus arrangement. Pyranol is circulated under pressure through each transformer and is cooled by tubular type water coolers. A separate and complete circulation and cooling

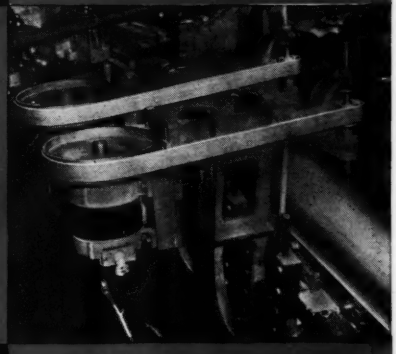
A Gilmer BELT FOR EVERY DRIVE

◀ *(Left)* **GILMER V-BELTS:** Space-saving, silent, shock-absorbing belts, built to lock in the grooves with a non-slip grip. Made in standard and special sizes.



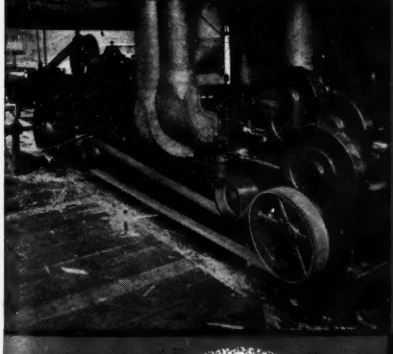
(Right) **GILMER HEVALOID ENDLESS BELTS:** ▶ Made under the Hevaloid patent with Neoprene compound that provides high co-efficient of friction. For precision work at top speed of 9000 f.p.m. Resists oil, heat, stretch and slippage.

◀ *(Left)* **GILMER SPEEDAGE BELTS:** Very light, lapless, flat, fabric belts for high speeds to 10,000 f.p.m. and over. Assures chatterfree production.



(Right) **GILMER KABLE KORD BELTS:** ▶ Rubber Fabric and tough continuous cord construction give you a contactor and power belt in one. Exceptional grip and strength combine in these flat belts with low-stretch, small slippage and extra tensile strength.

Gilmer also makes Round Endless Belts, Special Endless Belts, and Belts for Textile and other specialized industries. Write for the Gilmer Belt Catalogues . . . Free for the asking.



(Right) **GILMER RHO ENDLESS BELTS:** ▶ Flat endless belts, rubber-fabric, jacket-enclosed. Sturdy, light and very flexible, for speeds under 7400 f.p.m.

◀ *(Left)* **GILMER ENDLESS PLANER BELTS:** A typical special purpose belt of endless cord construction for planer and gang-saw drives.

USE WHAT YOU LOSE

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L. H. GILMER COMPANY

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The Oldest Firm of Rubber Fabric Belt Specialists

The Gilmer Engineering Staff has planned a National Power Recovery Plan . . . a FREE war-time service to industry . . . approved by the WPB . . . to save power in the following services: Steam, Gas, Electricity, Mechanical Transmission, Boilers, Compressed Air, Refrigeration and Prime Movers. Write for your FREE copy today.

The new U.S.-made "Megger" Insulation Tester in molded plastic case. Ask for Bulletin 1735-M.

When the need arises for emergency insulation testing of electrical equipment—it calls for immediate and positive action. "Megger" Insulation Testers are *always* ready for use, day or night, even in the most remote, isolated, inaccessible locations. The self-contained hand-cranked generator is a source of power that is reliable and wholly independent of any battery or other outside source. The "Megger" Tester is a complete unit in itself.

For occasional use, for periodic tests and for emergency tests, your "Megger" Tester is *always ready.* If you do not have full information on how to use and operate "Megger" instruments, write for a free copy of the Pocket Manual of "Megger" Practice, No. 1420-PE.

JAMES G. BIDDLE CO.
1211-13 ARCH STREET • PHILADELPHIA, PA.

"MEGGER"
TRADE MARK REGISTERED U.S. PAT. OFF.
Insulation Testers, Ground Testers and Ohmmeters

system is provided for each of the three transformers.

All of the 22 kv equipment is of the steel housed, factory assembled type and each of the two buses with its associated oil circuit breakers and disconnects is installed on a separate floor of the extended switchhouse. The oil circuit breakers have a rated interrupting capacity of 1,500,000 kva. From the main buses each outgoing feeder is provided with reactors, potential transformers, combination line and grounding disconnecting switches and potheads, all mounted in the factory assembled steel housings. Complete key type interlocks are provided on all disconnects and access doors to assure the proper sequence of operations for switching, inspection or test.

Flood Control and Coal Handling

The story of the 1942 extension to South Meadow Station would not be complete without reference to the flood control activities which were in progress simultaneously with the station construction program, and the major addition to the coal handling facilities necessitated by the oil conservation program.

The original flood protection for the Hartford area consisted of an earth dike designed to protect for flood waters up to a crest of 35 ft. In the vicinity of the station, however, this dike afforded no protection since its location was west of the station. In other words, the station property was between the dike and the river.

During the disastrous flood of 1936, the river reached a crest of 37.5 ft so that even the dike afforded no protection and, obviously, the lower portion of the station was inundated, resulting in a complete shut-down for over a week. Plans for the Connecticut Valley Flood Control were initiated immediately following this flood under Government sponsorship and the final design for the area immediately adjacent to the station was a reinforced concrete flood wall with a riprap base between the station and the river, arranged to give protection up to a flood level of 45 ft.

Progress of events was such that the construction of these flood control works proceeded coincident with the station extension and it should not be difficult to picture the resulting conflictions. The necessity of maintaining condensing water intake and

Why the **MP** *in this* POWELL VALVE *ad?*

Well—you know what "Military Police" signifies, don't you? It's the designation of specially qualified, specially fitted men who are charged with the duty of seeing that "things run smoothly." One of their most important functions, wherever troops and supplies are located, is to *control the flow* of traffic.

So—that "M P" is in this advertisement because he signifies the thorough-going job performed by POWELL VALVES in every branch of industry—in *controlling the flow* of liquids and gases—often under the most exacting conditions.

The Wm. Powell Co.
Dependable Valves Since 1846
Cincinnati 22, Ohio

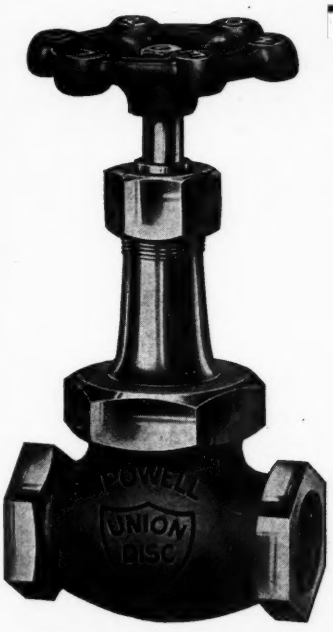


Fig. 150—Bronze "Union Disc" Globe Valve for 150 pounds W.P. Screwed ends, union bonnet, and renewable vulcanized composition disc—especially adapted for throttling service—for the control of low-pressure steam, oil, water, gas, etc.

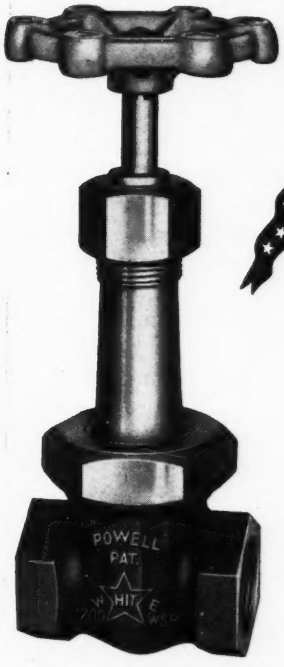
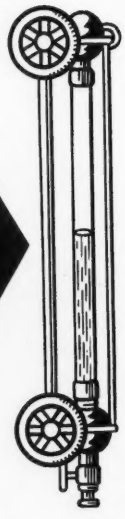


Fig. 375—200-pound Bronze Gate Valve with screwed ends, union bonnet, inside screw rising stem and special hard bronze disc. Sizes ¼" to 3", inclusive.

POWELL VALVES

MAINTAIN PROPER BOILER WATER LEVELS



CONTINUOUSLY • AUTOMATICALLY • ACCURATELY

under all LOAD CONDITIONS *with*

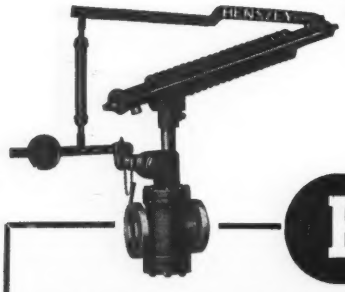
HENSZEY *Boiler-Feed* REGULATORS

The Henszey Regulator offers a dependable method of boiler water level control-helping to prevent the hazards of high water levels as well as low water levels. The unit is easily installed right in the feed line—no additional structural supports are needed. Once installed and set for operation no further attention is necessary—nothing to get out of order—nothing to rust.

Avoid the burned out tubes, cracked headers and even serious explosions that can result from low water levels. Avoid the damages that can be caused by water slugs being carried into the steam lines from high water levels.

Plan now for continuous, automatic boiler water level control . . . investigate Henszey Boiler Feed Regulators.

Made for pressures up to 600 lbs. and in sizes up to 4 inches.



HENSZEY COMPANY

Dept. C1, Watertown, Wis.

HENSZEY

BOILER FEED REGULATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers

Feed Water Meters • Flow Indicators • Proportioning Valves

discharge facilities to the existing station, the construction of similar facilities for the new unit and the installation of new coal handling and storage equipment presented many involved and interesting problems.

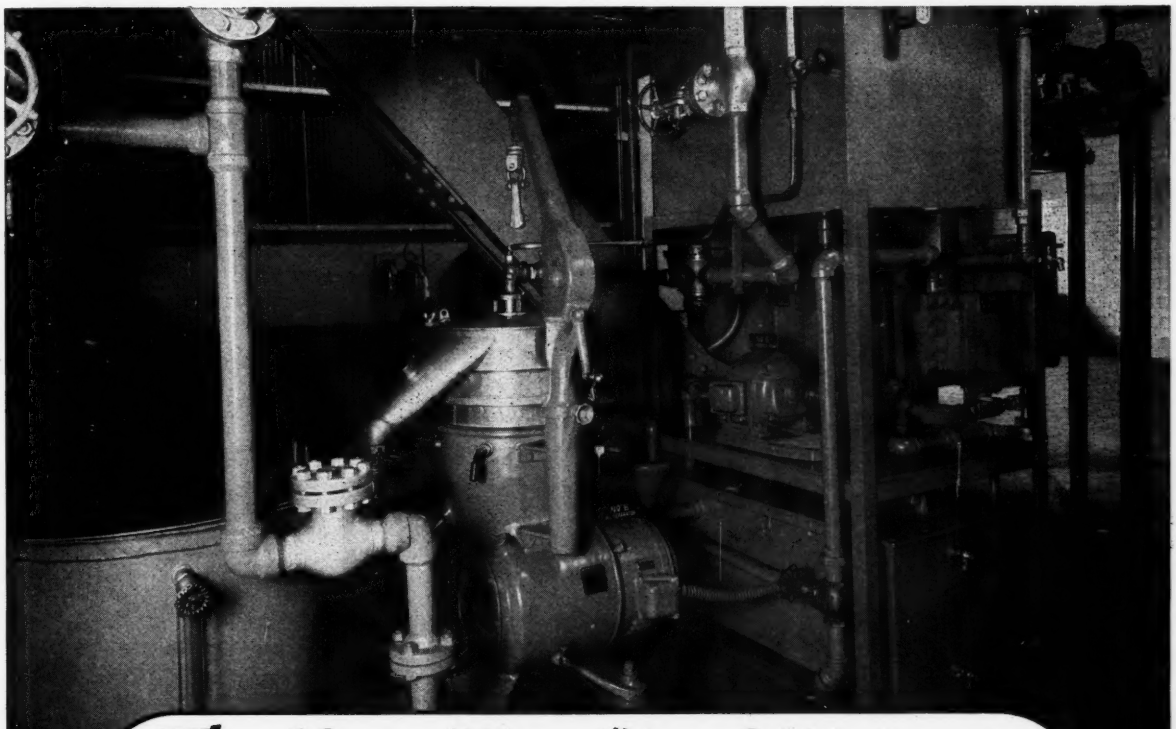
Immediately after Pearl Harbor, it was obvious to those concerned with the supply of petroleum products that serious shortages would inevitably result. Although all of the major equipment at South Meadow had been designed for either oil or coal firing since 1930, the primary fuel since that date had been oil. A new 130,000 bbl oil tank had already been ordered for the new extension.

Early in 1942 this order was held up and designs were started on an emergency basis for additional coal handling and storage facilities. These consisted primarily of a new river unloading tower to handle barge coal, two transfer houses, a storage delivery tower, a reclaiming pit and ten new belt conveyors to provide flexibility of handling and supply. A major ground preparation and grading project was required in order to more than triple the then existing storage facilities. Also, as barge shipments are blocked during extended periods of the year due to ice and storms, greatly expanded facilities for the receipt of coal by rail were required. This involved the leveling of the old earth dike to provide a right-of-way for a new loop track from the main line of the railroad some 1500 ft away, and the construction of a new spur with a suitable car unloading trestle well into the area of the enlarged storage yard. The arrangement of these new facilities on the station property and a schematic diagram of the conveyor and handling equipment are shown in Fig. 7. The unanticipated expenditure for these additional coal handling facilities ran close to $750,000.

The construction and engineering on the 1942 extension was done by Stone & Webster Engineering Corp., who designed the original station as well as all subsequent extensions. All operations were carried on under the personal supervision of T. H. Soren, vice president in charge of engineering, of The Hartford Electric Light Co.

Note: All photographs presented with this article were taken by George E. Meyers, Inc., Hartford, Conn.

This DE LAVAL-FUNK PROCESS *is*



The "Last Word" in Efficient TURBINE OIL PROTECTION

THE De Laval-Funk Process shown above is installed in one of the great central stations in the East. All of the oil used to lubricate the turbines in this giant power plant is processed and centrifugally purified by this means, greatly reducing the formation of sludge within the turbine lubricating system, and assuring that only purified oil returns to the turbine reservoir.

Operators of all forms of prime movers who are charged with the trouble-free maintenance of their equipment, know that De Laval Oil Purifiers protect vital bearings by keeping the lubricating oil free from dangerous impurities, including water.

De Laval Centrifugal Oil Purifiers maintain oil in a condition most nearly identical with that of new oil and make possible uniformly high purifying efficiency, with long, trouble-free service.

Both De Laval Oil Purifiers and the De Laval-Funk Process are available in various capacities and are equally well adapted to small power plants.

Write for bulletin giving details

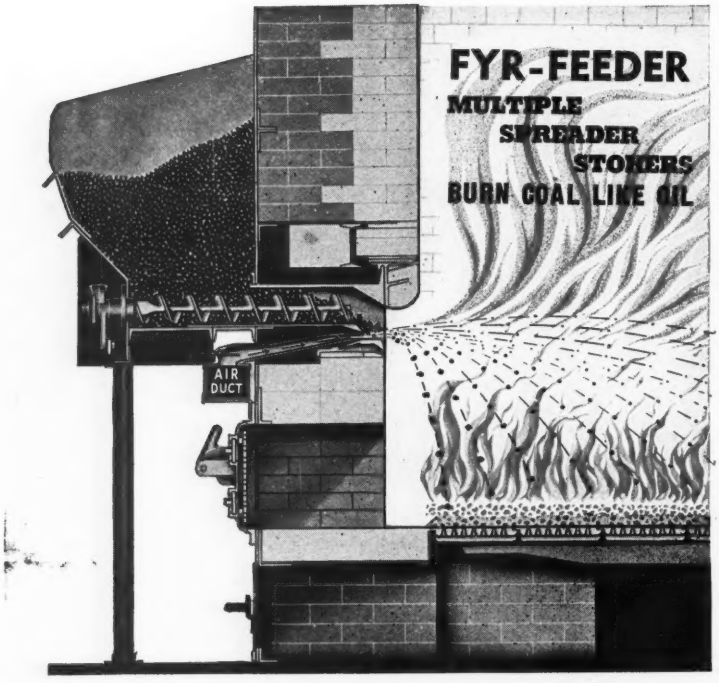
THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York, 6 427 Randolph St., Chicago, 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco, 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

DE LAVAL *OIL PURIFIERS*

FOR MORE DEPENDABLE POWER PRODUCTION

FYR-FEEDER

Multiple SPREADER Stokers



Burn Coal Like Oil!

Whether you need to convert to coal to solve fuel problems, or need greater steam capacity, FYR-FEEDER stokers give you the short-cut answer to both, with additional and important advantages.

Higher Steam Capacity with present equipment may do away with the need for an additional boiler. Many FYR-FEEDER stoker owners have done this. One outstanding example is that of a plant that raised peak rating on a 400 H.P. boiler from 175% to 325%.

Fuel Savings. Another FYR-FEEDER economy is the ability to burn coal that is available locally — any kind of bituminous coal screenings or coal yard sweepings — any type from free-burning to coking coal.

Better Combustion. FYR-FEEDER burns fines in suspension, larger pieces on the grates. Thin fuel bed; coal is spread over the grate, with greater active coal burning area. No dead plates; no clinkers. Fires cleaned in two minutes.

Quick Delivery. Priorities are being granted to plants requiring conversion or more steam capacity, and we can make quick delivery. Installed in large or small boilers with minimum loss of production time and without major alteration to present equipment.

Get in touch with us for an engineer to survey your plant for recommendations on a FYR-FEEDER installation. Full assistance in conforming to priority regulations.

WRITE FOR THIS CATALOG showing results obtained with FYR-FEEDER.

AMERICAN COAL BURNER COMPANY
ENGINEERS • ESTABLISHED 1918

22-18 East Erie Street • Chicago 11, Illinois

The 2500-psi Twin Branch Plant—Operating History

(*Continued from page* 81)

enced with the boiler-drum safety valves due to warping of seats and disks. Corrective measures are still in the experimental stage. This also holds true of the boiler-drum gage glasses. The high pressure apparently causes some assembly distortion and that, coupled with other factors, is resulting in considerable leakage and shattering of glass, thus requiring frequent and specialized maintenance attention.

Figure 1 indicates that the availability of the unit compares favorably with most power installations operating at even as low a value as one-third the pressure of Twin Branch. Except for a small deficiency in primary-steam temperatures, the boiler is meeting all expectations. In this connection there are given in Table 2 the results of two efficiency tests which were conducted in May, 1943. In Table 3 there is given a summary of operating results covering the period beginning March 26 to August 31, 1943. Without going into the merits or demerits of other thermal cycles or equipment, Twin Branch experience has shown that 2500-psi natural-circulation boilers and 2300-psi steam turbines, with their related equipment, can be made to give a power plant that is technically and commercially sound.

Tests on Coal-in-Oil Fuels

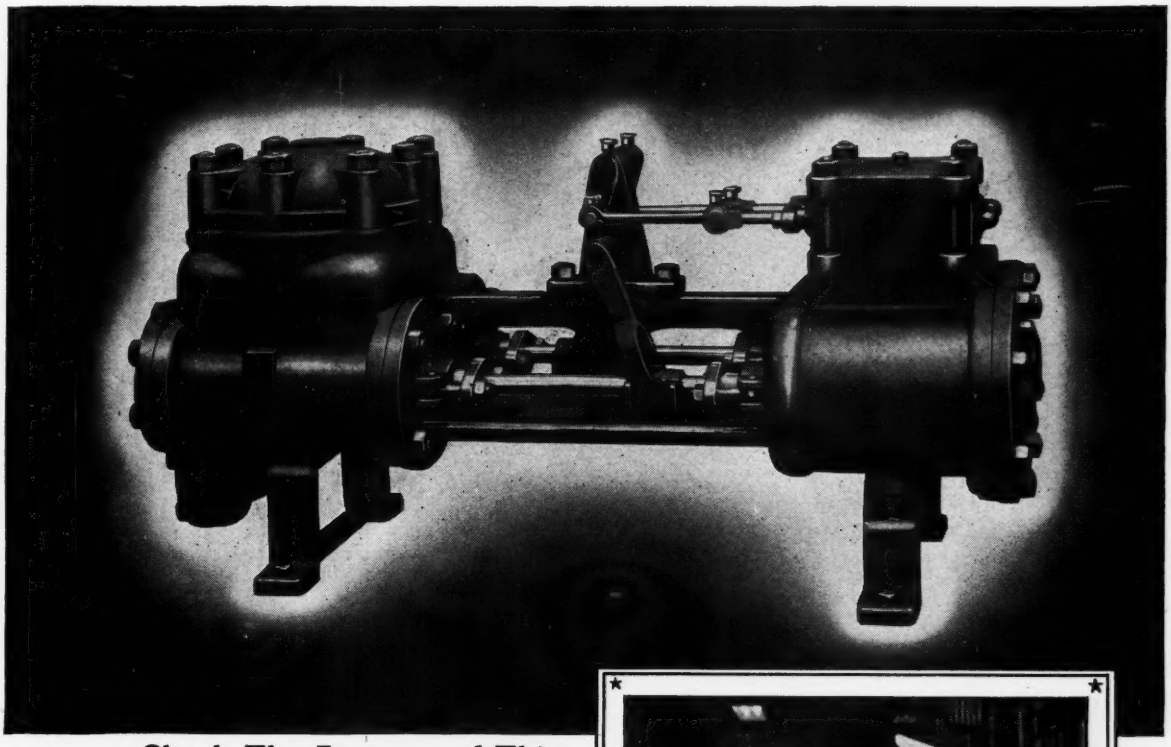
(*Continued from page* 84)

throughout the day the fuel control valve tended to clog, but it could be readily cleared by opening it wide quickly. Control-valve clogging would be apt to create some difficulties under automatic control. The burner tip occasionally clogged a little and had to be blown clear with a shot of steam piped to blow through the oil slot.

Coal-in-oil fuels with their higher specific gravity and viscosity present new pumping problems when used in oil equipment.

About 30 lb pressure was in general maintained ahead of the burner oil-control valve for both oil and coal-in-oil fuels. Much higher relative pressures were required for the coal-in-oil fuels. The electric inputs to pump motors were increased. Under one set of operating conditions this input was about doubled.

A Pump With A Future That's Beginning Right NOW...



. . . Check The Features of This WARREN REALWEAR Horizontal Duplex Piston Pump

Here's good news for Industry . . . and Post-war Planners! The Realwear Type of Warren Pumps are becoming available in standard sizes again in limited quantities for commercial uses.

Warren Realwear Horizontal Duplex Piston Pumps have made unusual endurance records, low maintenance records and operating efficiency records. Like all Warren Pumps they are "built to fit the job" . . . with no compromising with sound engineering and construction features. And as an added PLUS value, extra wear and corrosion resistance is **standard** with these Warren Realwear Pumps.

Check over the following features of these pumps.

- One-piece type stainless steel piston rods
- Engine-type stuffing boxes, with glands held by swing bolts
- Renewable bronze bushings for valve gear links
- Multi-disc type pump valves of stainless steel
- Valve stems protected against wear by renewable bronze sleeves
- Centrifugally cast bronze cylinder liners

Investigate the Warren Realwear Pumps for **your** plant. Send for more information . . or write for bulletin or Warren catalog.

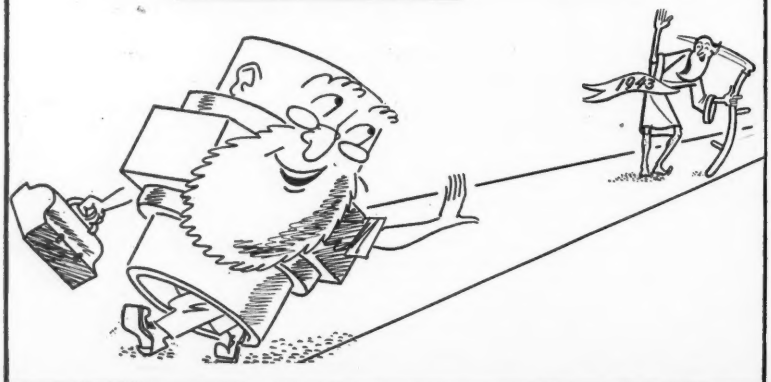
WHEN OUR COUNTRY WAS ATTACKED our Navy . . Army . . . Merchant Marine and War Industries needed more and more Warren Pumps — and Warren has been "all-out" ever since. It is the pride that our skilled workers take in Warren Pumps that enable Warren Equipment to perform so faithfully under the do-or-die conditions of war production and battle. And it is this pride that enabled Warren Workers to win the Army-Navy "E" Award — at the presentation of which this picture was taken.

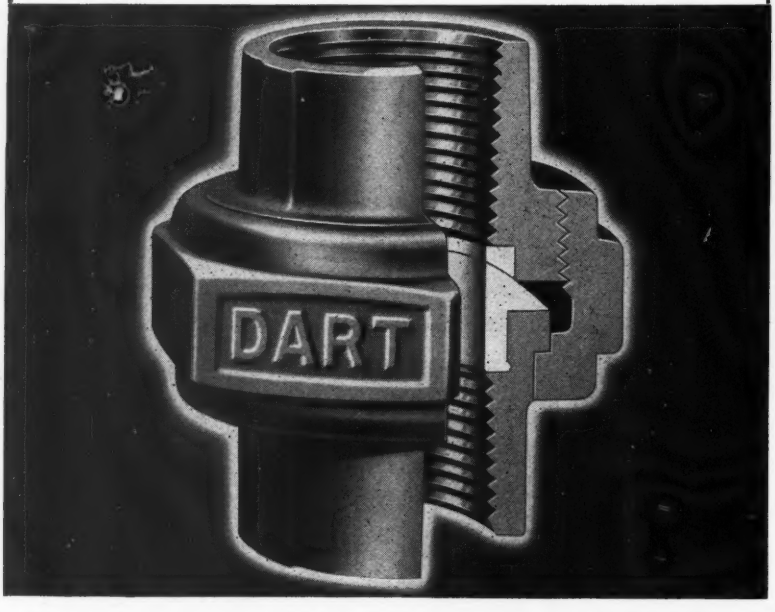
ARMY E NAVY

WARREN STEAM PUMP CO., INC.
WARREN, MASSACHUSETTS

EXIT 1943

...but Old Dart Unions Still Carry On





The old year has gone . . . but old Dart Unions, even though they have already seen a lot of service, are still very much in the picture . . . ready and able to go back to work and give more dependable, economical performance.

This extra Dart Life is largely due to these important factors. First, Darts have matched bronze seats, ground to true-ball surfaces. Second, Dart bodies and nuts are made of high test air refined malleable iron that resists rough handling and rust.

Help give the New Year a good start by making another search of your plant for used Dart Unions to put back to work. And if you need *new* Darts, get in touch with your supplier promptly.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

For the rotary pump used the capacity dropped about 20 per cent. No satisfactory measurement was obtained in the loss of capacity of the reciprocating pump. The higher viscosity fuel causes the valves of reciprocating pumps to seat at a slower speed; stiffer valve springs helped to overcome this difficulty.

Coal-in-oil fuel was found to be rather abrasive. It acted something like a lapping powder. There was also cutting of the burner tip.

Tests at Cambria Silk Hosiery Co. Boiler Plant

A part of the Batch No. 4 coal-in-oil fuel was burned in the boiler plant of the Cambria Silk Hosiery Co., Philadelphia, Pa. This plant was typical of the smaller industrial plant burning No. 6 fuel oil. The boiler used on the trial was a typical brickset 72-in. by 18-ft 150-hp H.R.T. boiler, equipped with one burner. The burner was a standard Johnson type 30-H automatic on-and-off rotary-cup burner having a maximum capacity of about 90 gph of oil.

On the delivery side of the pump it was found necessary to change the size of the orifice from 0.0935 in. diam as regularly used, to a larger orifice 0.161 in. diam to lessen restriction of flow. Under normal operating conditions with oil and with the smaller orifice, an oil pressure of about 15 to 18 lb was carried; with coal-in-oil fuel and with the larger orifice, a pressure of about 20 to 23 lb was required for the same load. The 24-mesh screen ahead of the electric heater became clogged after about 3 hr; a larger mesh screen would be desirable for coal-in-oil fuels. The final temperature of the fuel to the burner ranged in general from about 140 to 160 F.

When starting with a comparatively cold furnace, it was found that the automatic ignition would not ignite coal-in-oil fuel; a hand torch had to be used. A larger gas pilot was needed. With a hot furnace, however, the automatic ignition operated quite satisfactorily.

The revolving cup of the burner for use with oil fuel was tapered outward somewhat. The flame of the heavier coal-in-oil fuel flared out from the cup more than the flame of the oil. This caused carbon masses to accumulate on the circular brickwork throat of the burner, which had to be cleaned about every 15 min. The tapered cup of the burner was changed to a straight-line cup; the brickwork of the throat was flared out a little farther. These changes resulted in

TALON'S ELECTRIC WELDED STEEL TUBING USED FOR MANY APPLICATIONS IN HIGH OCTANE GASOLINE PLANTS

Our mighty war birds have tremendous power and "stratospheric" performance for which credit is due to the product of America's great octane gasoline plants.

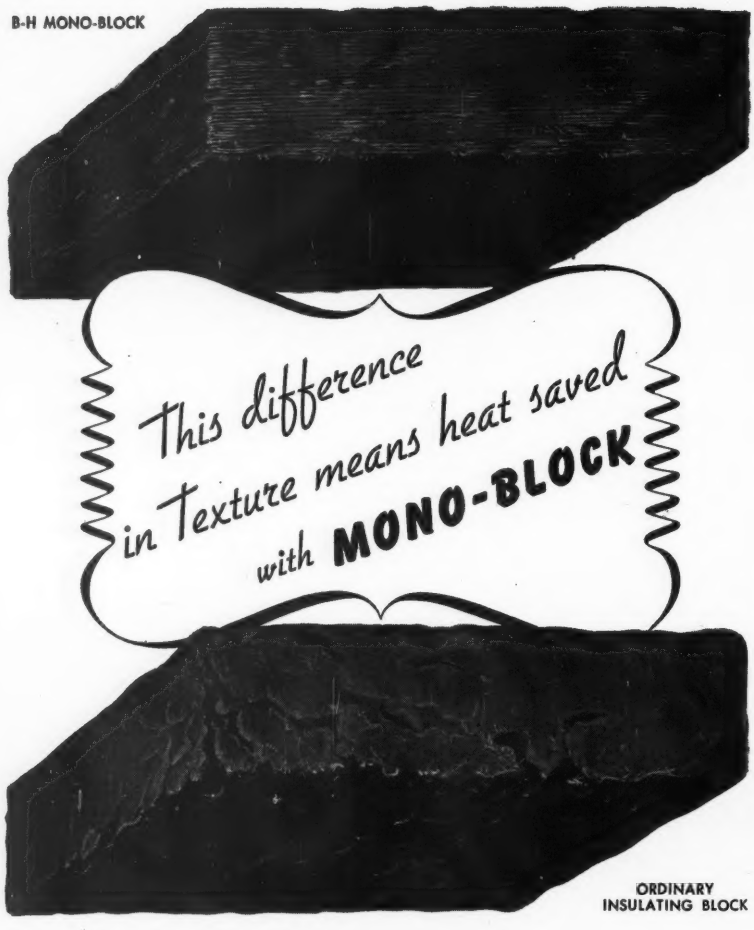
The process of producing high octane gasoline, which sends our planes faster, farther, and higher, involves tremendous pressure and extreme heat. Because Talon's Electric Welded Steel Tubing stands up under this gruelling operation, it is used with confidence in heat exchangers, boilers, condensers, and superheaters. The concentricity, uniform wall thickness, and ductility of Talon's Tubing help speed original installation work. Once on the job, it stays put, resisting the combined ravages of heat and pressure.

Investigate the possibilities of using Talon's Electric Welded Steel Tubing in your business for pressure or mechanical applications.

PRESSURE MECHANICAL

TALON . . INC.

STEEL TUBE DIVISION OIL CITY, PENNA.



Note how the long, straight fibres in B-H Mono-block are interwoven in layers by an exclusive, patented process. Here is the reason why Mono-block is lighter, more efficient. A veritable army of millions of tiny air-cells in each block holds back the heat and prevents its escape.

Mono-block is a one-block insulation, effective over the full temperature-range up to 1700° F. This means substantial savings in installation costs. Its felted surface yields to rivet-heads, welds, and other surface irregularities without cracking or breaking. Made from *black* rockwool, it is high-temperature-resistant and has exceptionally low thermal conductivity. It will pay you to investigate B-H Mono-block. Send for sample and new bulletin.

Baldwin-Hill Co., 577 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J., Kalamazoo, Mich., and Huntington, Ind.

Baldwin-Hill

BH COMPANY

HEAT & COLD INSULATIONS

satisfactory operation. The burner was readily adjusted and the CO_2 could be carried as chosen. Somewhat improved operation could be had by heating the fuel to about 160 to 170 F ahead of the burner. The efficiency when coal-in-oil fuel was used was about the same as when oil was used. The maximum load on the boiler with coal-in-oil fuel on this installation was approximately 10 per cent less than with oil. This was caused primarily by the difficulty of supplying enough secondary air in the right spots. The fly-ash problem was of little moment.

Tests at National Airoil Burner Co. Heating Plant

In cooperation with the National Airoil Burner Co. of Philadelphia, Pa., part of Batch No. 4 of coal-in-oil fuel was tried in its office headquarters' heating boiler. This boiler was a cast-iron sectional boiler having an output of about 3,060,000 Btu (approximately 90 hp). It was equipped with a small rotary-cup burner of a capacity of 20 gph of oil. This plant was typical of the small heavy-oil-burning heating plant.

Normally the plant uses No. 6 oil pumped from an underground storage tank. Since it was believed that the regular burner setup would not be able to pump coal-in-oil fuel from the underground tank, a 275-gal tank was installed above ground.

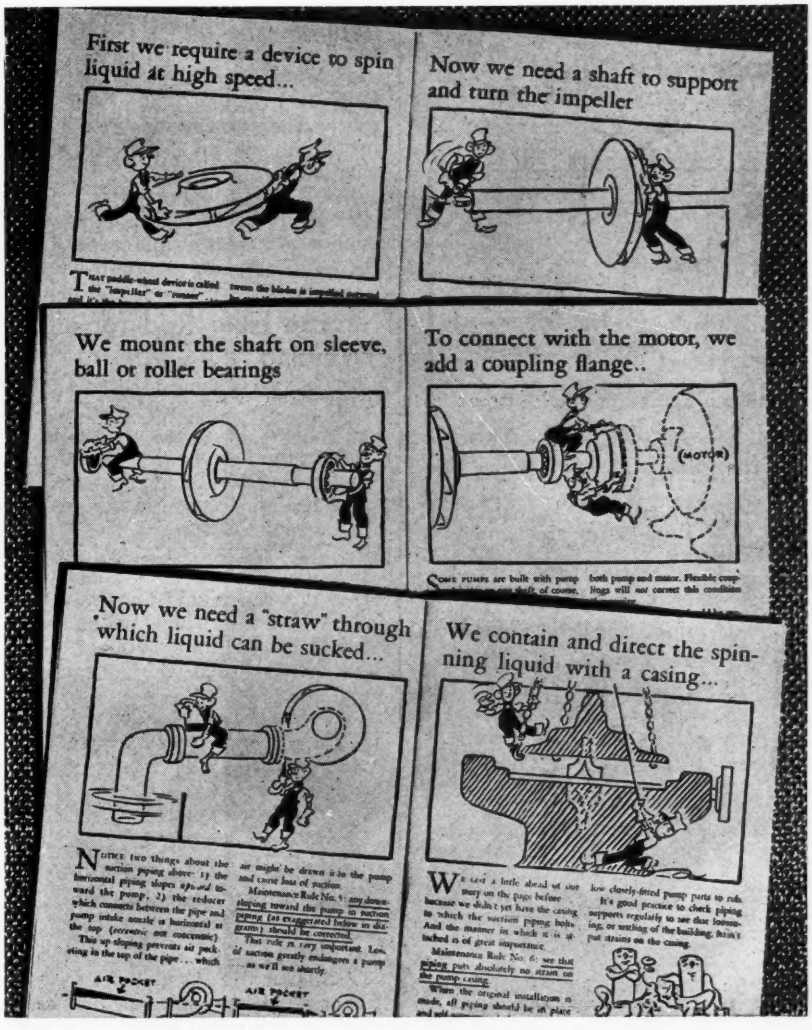
The oil burner was started with oil, and normal operation was established. The equipment was switched to coal-in-oil fuel having a temperature of about 68 F. The pump suction registered 20 in. of vacuum and was held at this point for 1 hr, but no fuel reached the burner. The equipment was switched back to oil, and the vacuum dropped to 15 in., giving a good oil flow.

Conclusions

Coal-in-oil fuel has its own peculiar characteristics which must be given thorough consideration for each job if satisfaction is to be obtained. However, this fuel does not present a particularly difficult problem in devising equipment and operating routine for efficient use. It appears that in some instances premixing of the fuel might be eliminated. The information obtained from this work on bituminous coal-in-oil fuels leads to the following conclusions:

1. A sufficiently stable suspension of coal in oil for practical purposes can be prepared by dispersing

Let's Build a Pump!


First we require a device to spin liquid at high speed...
Now we need a shaft to support and turn the impeller
We mount the shaft on sleeve, ball or roller bearings
To connect with the motor, we add a coupling flange..
(MOTOR)
Now we need a "straw" through which liquid can be sucked...
We contain and direct the spinning liquid with a casing...

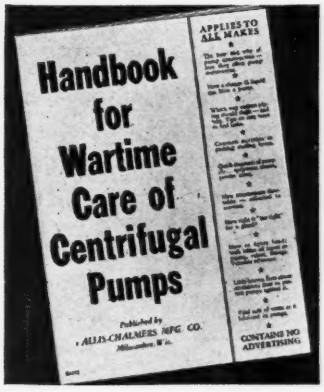
When you do need new pumps — look into the extra efficiency, ruggedness and long life of Allis-Chalmers centrifugal pumps... the famous "Electrifugal"... and all types for every purpose.

ALLIS-CHALMERS
MILWAUKEE

WE WORK FOR VICTORY — WE PLAN FOR PEACE

A PUMP IS BUILT— STEP BY STEP— IN A-C'S NEW PUMP MAINTENANCE GUIDE. AS EACH NEW PART IS ADDED, WE SEE WHAT IT DOES, HOW IT DOES IT, HOW IT MUST BE CARED FOR.

WITH MOST PUMPS today doing *3 and 4 times* their normal work, they need the finer kind of care set forth in Allis-Chalmers' new "Handbook for Wartime Care of Centrifugal Pumps". Every executive, engineer and maintenance man should have a copy of this informative book in his technical library!



This book applies to *all* makes of pumps — contains no advertising! Contents include: new preventive maintenance tips; *war* timetable for pump care; valuable tables, etc. Tear out coupon and send in now for your *free* copy!

ALLIS-CHALMERS MFG. CO.
Milwaukee 1, Wisconsin

Gentlemen:

Yes, I would like to receive, *free of charge*, a copy of your "Handbook for Wartime Care of Centrifugal Pumps".

(Name)

(Title)

(Company)

(Street Address)

(City and State)

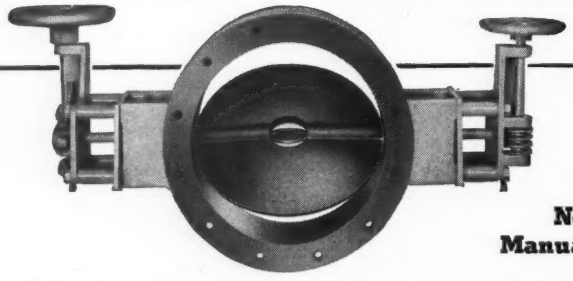
A 1653-4

A Single Valve with a DUAL PURPOSE

(PATENT APPLIED FOR)

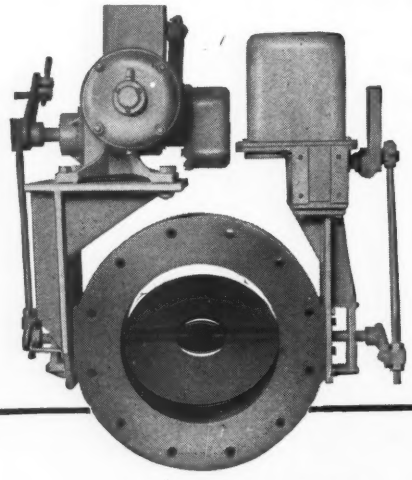
Designed for Either a High Pressure Drop and Small Volume or a Low Pressure Drop and Large Volume

Operates Beyond the Limitations of a Single Valve



No. 608
Manual Control

Close control of volume and pressure can be obtained with this dual-purpose hand wheel operated R-S Butterfly Valve. The large vane seats against the body of the valve while the smaller vane is free revolving. Both vanes are hand wheel operated. Only four to six revolutions of a hand wheel are required for complete opening or closing.



No. 583
Power Control

15 to 900 psi

Detailed information and catalog furnished upon request.

VALVE DIVISION

R-S PRODUCTS CORPORATION

4535 Germantown Ave. • Philadelphia 44, Penna.

R-S Streamlined BUTTERFLY VALVES

40 per cent coal by weight, ground from 98 to 99 per cent through a 230-mesh screen, in heavy fuel oil. The coal must be ground to this fineness to avoid most of the difficulty arising from unstable suspensions.

2. Mixing the coal into the oil does not present a particularly difficult problem.

3. Careful control of storage and handling temperatures is required for most successful operation.

4. Careful attention must be given the pumping of coal-in-oil fuels, particularly in cases where underground storage tanks are used.

5. The combustion efficiency of coal-in-oil suspensions is apt to be slightly less than that of oil.

6. The load-carrying flexibilities of oil and coal-in-oil fuels are about the same.

7. The best opportunity for the successful use of coal-in-oil suspension is in the larger plants with the better operating personnel and more readily accessible equipment.

Bronze Filler Rod for Welding

BRONZE is being used as a filler rod in oxy-acetelene welding A galvanized iron water pipe of a uniformly low melting point and easily controlled flow was welded with a high strength bronze known as Oxweld No. 21.

The weld produced a hard resistance to wear. It is understood that this rod is said to have a tensile strength of 45,000 psi and that it may be used for welding of brass, bronze, malleable and grey iron castings.

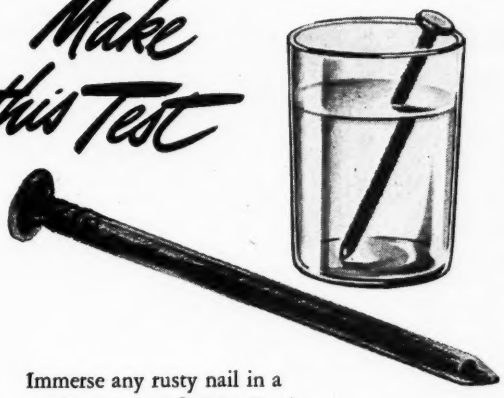
In the use of this filler rod, boiling and annoying fuming of the weld metal is almost entirely avoided, while gas and oxide inclusions are eliminated, thus resulting in a sound weld.

Metal Stronger When Broken Under Impact

PRECIOUS WAR MATERIALS may be saved, or the strength of critical parts increased, as a result of tests showing that some metals have higher strength when they are broken under quick impact than when they are slowly pulled apart. These results were reported at the recent N. Y. meeting of the American Society of Mechanical Engineers, by Dr. R. O. Fehr, of the General Electric Company's General Engineering Laboratory. The studies were made in collaboration with Earl R. Parker of the G. E.

What to do about Rust?

Make this Test



Immerse any rusty nail in a small quantity of Cities Service Rust Remover. If badly rusted, allow to remain for several minutes. You can actually see the rust dissolve.

See the Results

Remove nail and wipe dry with cloth or tissue. Note the complete absence of rust and the way the original surface reappears.

CITIES SERVICE RUST REMOVER has been tested for four years throughout a small, highly industrialized area in the East, where it has earned a unique reputation for performance. RUST REMOVER is a clean, clear liquid, practically odorless, non-inflammable, easily applied, and harmless to handle by those not allergic to specific chemicals. It is fast-acting, and, although heating somewhat accelerates results, general application is recommended at normal temperature (60°-90°F.). RUST REMOVER is effective on chromium, copper, aluminum, steel and iron.

5 Big Advantages

1. Non-Inflammable
2. Harmless to Normal Skin
3. Makes Metals Chemically Clean
4. Removes Rust by Chemical Action
5. Free from Muriatic, Sulphuric, Nitric and Oxalic Acids or Cyanide.

See a Free Demonstration of Rust Remover on Your Own Equipment.

(Available only in Cities Service marketing territory EAST of the Rockies.)

MAIL THIS COUPON TODAY!

CITIES SERVICE OIL COMPANY
Room 107
Sixty Wall Tower, New York 5, New York

Gentlemen: I'd like to test RUST REMOVER on my own equipment FREE OF CHARGE. Send me details.

Name.....

Company.....

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City.....State.....

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CITIES SERVICE OIL COMPANY
NEW YORK · CHICAGO

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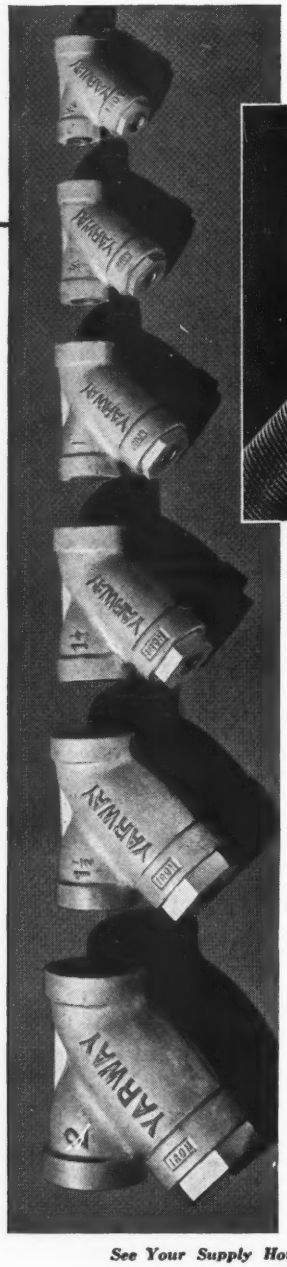
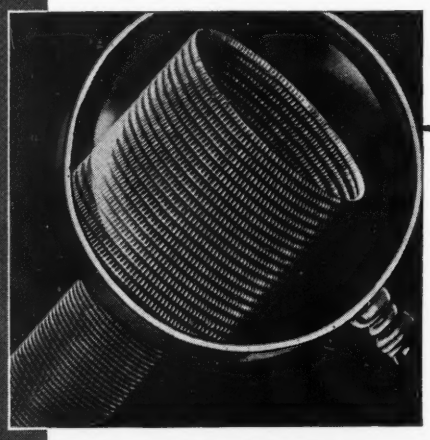
PREVENT

Rust·Scale·Dirt

FROM CLOGGING
STEAM EQUIPMENT





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STRAINERS

"The Screen's the Thing"

- *A High Grade Monel Woven Wire Basket* with mesh fine enough to catch the dirt—yet ample free area for passage of clean condensate, oil and other fluids.
- *Body Cadmium Plated Inside and Out for Protection Against Corrosion.*
- *Readily Removed Steel Blow-Off Bushing.*
- *Bushing Automatically Aligns Screen.*
- *Thousands in Use—Sold by Over 100 Mill Supply Houses.*
- *6 Sizes ½" to 2" for Pressures up to 600 Lbs.*

See Your Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY

114 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS

Research Laboratory and with the assistance of D. J. DeMicheal of the General Engineering Laboratory.

In ordinary static tests of the strength of metals, a test bar is subjected to a gradually increasing load in a special testing machine, and minutes may elapse before the bar is broken. In the machine used by Dr. Fehr and his colleagues, the test bar is broken by a hammer revolving on a heavy wheel at high speed. With this machine it is possible to hit the bar with the hammer traveling as fast as 100 ft per sec (about 70 miles per hr). At these speeds, the front of the test is subjected to an acceleration, or "speed-up," of about 100,000 times what it would acquire under the influence of gravity.

Cold-rolled steel and duralumin, both widely used metals, the latter particularly in airplanes, were tested, Dr. Fehr reported. He said that as the speed of impact was increased to 100 ft per sec, an increase in strength up to about 30 per cent was obtained. He pointed out that this gives an additional factor of safety in designing machinery and other equipment.

"At the present time," he declared, "designs of apparatus are based mostly on the static characteristics of the different materials even when the apparatus is subjected to impacts. When the dynamic breakage strength is lower than the static breakage strength, the apparatus may not withstand the impact, and when the dynamic strength is above the static value, the weight of the apparatus may be unnecessarily high. Design of apparatus subjected to dynamic loads can be improved, therefore, when based on the dynamic characteristics of materials."

5000-kw Power Plant on 8 Railroad Cars

MODERN WAR is responsible for the design of a complete 5000-kw central station—completely assembled to make a railroad train of 8 cars. This power train is suitable for use in almost any part of the world. It has been designed to use coal of unusually low quality. It is suitable for arid or devastated regions where water may be so scarce it would have to be delivered in tank cars. It will work where temperatures range from 110 deg above to 40 deg below zero F. According to Westinghouse engineers, this rolling power plant can be hauled by a locomotive to any spot where railway tracks exist—in about 48 hr it can be made ready to deliver power.

In wartime such power trains can follow victorious armies into recaptured areas to rehabilitate local industry. Conversely, it can be removed from areas about to fall into the hands of an ad-

MIDWEST WELDING FITTINGS

IMPROVE PIPING DESIGN • SAVE TIME • REDUCE COSTS

Qualified welders experienced on all kinds of piping report that Midwest Welding Fittings have exceptional dimensional accuracy and uniformity... saving time in layout because all pipe can be cut in advance according to drawings... saving time in lining up and welding... assuring more uniform welds.

Midwest originated and developed many of the fittings shown here: the "long tangent" elbows, saddles, sleeves, shaped nipples, and lap-joint stub ends with large radius and heavy forged lap. Midwest Saddles compensate for the weakening of header body resulting from the metal removed for neck opening; Midwest Sleeves relieve butt welds of any bending stress and much of tensile stress; Midwest Shaped Nipples eliminate all layout and templates when saddling one pipe upon another; etc. Get Bulletin WF-41 for complete information.

MIDWEST PIPING & SUPPLY CO., INC.

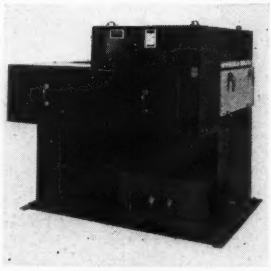
Main Office: 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—645 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Bldg.

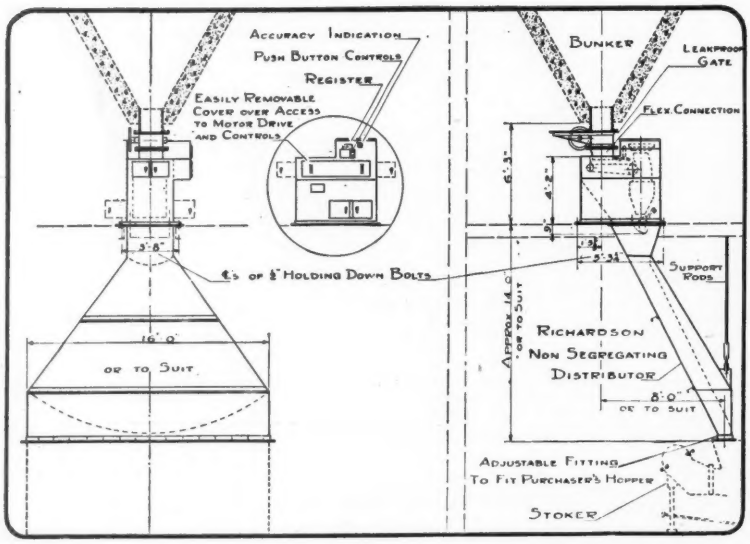
SAVE COAL
Simplify
S. F. C. REPORTS WITH RICHARDSON COAL SCALES

Saving coal is the surest and quickest way of reducing your power costs. Richardson Coal Scales provide continuous fuel consumption records which at once show up any "bad actor" boiler that is operating below maximum efficiency, so that steps may promptly be taken to correct any improper condition, and thus restore that boiler to required operating standards. One Connecticut engine company estimates a saving of 2600 tons a year through using Richardson Automatic Coal Scales—a reduction of $20,000 annually in their coal bill and handling expense, plus the elimination of 52 carloads and 20 miles of trucking.



The same coal consumption records, accurate to ¼ of 1%, give you necessary facts for reporting to the Solid Fuel Coordinator on form S.F.C.-16—figures on coal burned per week, and coal remaining in storage. Richardson Coal Scales provide these figures without use of extra man-hours or additional conveyors to rehandle coal to storage.

Complete bunker to stoker (or pulverizer) installations. Richardson supplies inlet gates, scales to meet any needs, and distributors for stokers or connections to pulverizers. Help conserve coal and its transportation with Richardson Coal Scales. Forty-five pages of technical details, photographs and installation diagrams are provided by Bulletin 1143. Write for it.



RICHARDSON SCALE COMPANY
CLINTON, NEW JERSEY

4897

vancing enemy. In peacetime the trains can furnish power for flooded plants and for other similar emergencies.

The first 2 cars carry the air-cooled condensers while third car carries the turbine generator with switchgear equipment. Number 4 and 5 cars take care of auxiliary equipment and water storage. The water storage supply will run the train, under most severe conditions, for more than a full day without replenishment. Number 6 and 7 cars are for the boilers while car number 8 provides quarters for the crew and storage for lubricating oils, spare parts, etc.

The two boilers produce steam at 600 psi gage, 750 F from available coals —even lignite, having a heat content of only 7000 Btu per lb will work satisfactorily. Boilers are of water-tube, double-drum construction, have both forced and induced draft fans and have air-operated locomotive-type stokers. The single turbine-generator unit delivers to the bus 6250 kva at 80 per cent power factor, 6300 v. Power is delivered to a six-cubicle, metal-clad switchgear for distribution. Because intake ventilating air may be dusty or dirty, the generator is provided with a self-cleaning air filter. A Diesel-driven generator provides 75 kw capacity for plant and auxiliary purposes.

In many places where such a rolling power unit is needed, cooling or boiler water may be virtually non-existent or may be of poor quality. To meet this condition the condenser is air cooled and the condensed steam is reused. Four motor-driven propeller fans draw air over eight coolers in each of the condenser cars. Even with cooling air at 95 F the condensers are able to condense the full amount of steam; the condenser water is then pumped back to the feed-water tank car. By this method it is expected that less than three per cent make-up water will be required. All make-up water is filtered, softened, and evaporated in the auxiliary car.

Placing a modern 5000-kw plant into a train of 8 cars presented scores of engineering problems. The trucks were designed specially rigid so that no torsional movement of the frame in transit can rupture pipe connections. All apparatus—meters, shafts, gauges, etc.—are braced so as not to be injured by a sudden stop of the train. Pipe and electrical circuits between cars are disconnected while the train is en route. This necessitates having some means of aligning the cars preparatory to going into service. Because of the tight fit in the turbine-generator car, the sides are removable to give access to the generating unit should dismantling be necessary.

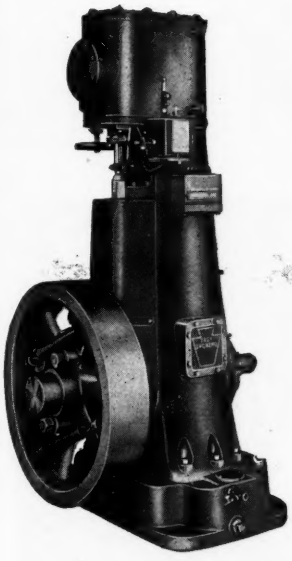
Heating Engineers to Commemorate Fiftieth Anniversary

Decisions of far-reaching importance are expected to be made at the 50th Annual Meeting of the American Society of Heating and Ventilating Engineers scheduled for January 31, February 1 and 2, 1944, at Hotel Pennsylvania, New York.

A Business Session will be opened by President M. F. Blankin on Monday, January 31, and the Greetings and Anniversary Messages received from various organizations will be presented, as well as the Annual Reports of Officers and Committees.

DESIGNED FOR BY-PRODUCT POWER

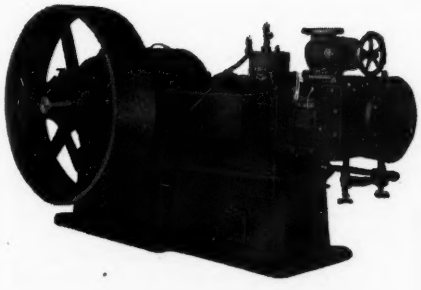
TROY ENGBERG



The Troy-Engberg Steam Engine—when plant heat balances are right—will produce maximum by-product power from steam which would be normally used for processing only. In effect, it is a huge reducing valve. It takes live steam from the boiler, extracts the power and sends most of the heat units on for heating or processing.

The modern steam engine is designed for double use—for the production of power and the saving of heat units originally in the live steam.

But in addition to its high by-product power value, the Troy-Engberg Steam Engine has other very useful characteristics. Its dependability and durability have never been surpassed by any other type of drive. Records show that hundreds have operated for fifteen to twenty years without requiring major repairs.



Its flexibility is widely recognized. In fact, one large utility recently purchased 24 Troy-Engberg Engines to drive 48 stokers. The superior flexibility of the engine was wanted. Many oil refineries prefer the steam engine to other drives, particularly for changing and transfer pumps, because of its dependability, ruggedness and simplicity. Quick starting, high starting torque and sustained overload capacity, too, are advantageous. For process plants, the engine can often be operated so as to produce oil-free exhaust.

Power from the Troy-Engberg Steam Engine is very desirable power—and often it's the most economical. Investigate it for *every* auxiliary drive in your plant.

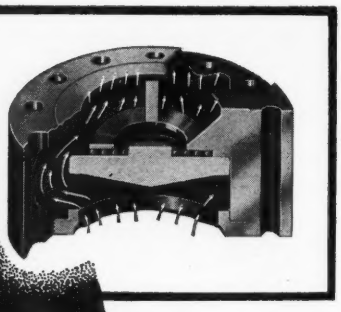
TROY ENGINE & MACHINE CO.

Established 1870

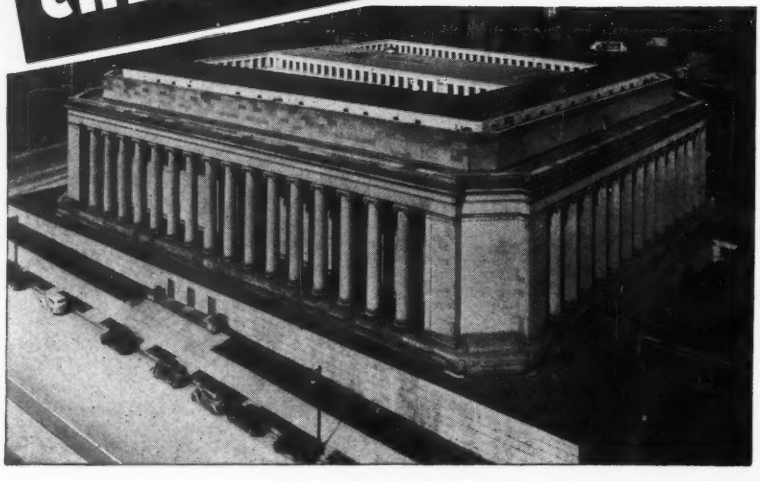
859 Railroad Avenue **Troy, Pennsylvania**

1—TEM—2

WILLIAMS-HAGER



FLANGED SILENT CHECK VALVES



Williams-Hager Installations Include:

Mellon Institute Pittsburgh, Pa. (Above)

Tennessee Valley Authority Fontana, N.C.

Statler Hotel Washington, D.C.

Prudential Life Insurance Building Newark, N.J.

Radio City New York City

Kaiser Co., Inc. Fontana, Calif.

Standard Oil (Indiana) Whiting, Ind.

WILLIAMS-HAGER Flanged Silent Check Valves—*tight* under *every* condition of service and pressure—assure unrestricted and uninterrupted flow of liquids. No webs to hamper flow . . . operates in any position . . . and of simple, compact design.

Available in iron, semi-steel, bronze, cast steel, stainless steel or monel . . . 1" to 20" inclusive, pressure resistant to 6000 pounds.

Write for this interesting brochure

THE WILLIAMS GAUGE COMPANY

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Pump Governors . . . Steam Traps Feed Water Regulators . . . Water Columns

3000 Pennsylvania Avenue, Pittsburgh (12), Pa.

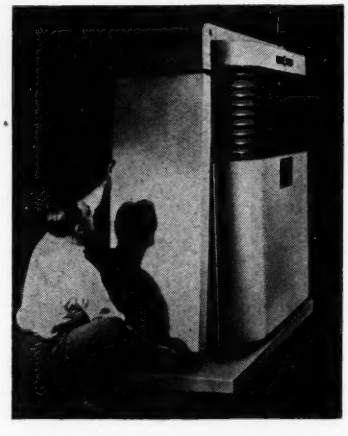
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE TO POWER PLANT ENGINEERING

Dry-Type Transformers

GENERAL ELECTRIC's line of indoor dry-type transformers for primary circuits 601 to 15,000 v provides greater safety and ease of installation than previous dry-type designs, as well as giving them an outward appearance of the latest model room-type air conditioning units. A radical departure from the screened enclosure which has characterized some of the dry-type units in the past, the new design employs sheet steel with flowing lines, smoothly rounded corners, and a two-tone gray finish.

The new case is highly functional, being designed especially for indoor installations in industrial plants. Horizontally louvered sections on two sides of the case can be removed easily, making the interior accessible for cleaning and tap changing. The taps are brought to a convenient terminal board located just below the edge of the casing and close to a diagrammatic nameplate. The deeply pitched louvers provide an outlet for the cooling air. Air is taken in at the bottom of the case through a screened opening along the bottom of each side, and is circulated through and around the coils by convection.



All live parts are metal enclosed, various portions of the case being separately removable. The high-voltage terminal compartment cover can be removed to facilitate connecting the transformer to the supply circuit. Similarly, access to the low-voltage terminals is gained by removing the low-voltage compartment cover. The solid side plate on each side of the transformer can be taken off to clean or inspect the core and coils.

Foxboro Valvactor

THE NEW FOXBORO Vernier Valvactor, just announced by The Foxboro Co., Foxboro, Mass., is a micro-positioner for pneumatic motor valves. It is used to insure precise and dependable valve response, especially where operating conditions may make the response uncertain, slow, or unsatisfactory. It is actuated by air pressure changes as slight as the equivalent of 1/2 in. of water, and can compel valve stem movements as small as 1/1000 in.

A Brief Outline of Dearborn Service and What the Dearborn Engineer Does:

(1) Studies your water and plant operating conditions.

(2) Sends samples of your water to main laboratory for analysis.

(3) Recommends proper chemical treatment and chemical control methods.

(4) Supervises installation of feeding equipment.

(5) Instructs your men on water test methods for treatment dosage adjustment and blow-down control.

(6) Calls regularly to insure maintenance of recommended conditions.

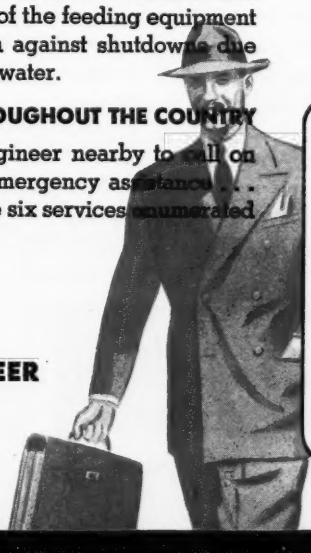
Boiler Water Treatment Service

...IN A NUTSHELL

Knowing where to turn for help in time of boiler trouble offers some consolation. How to forestall the trouble is infinitely better. If you are in trouble, the Dearborn Engineer can help you. If you want to forestall trouble, the Dearborn Engineer, backed by Dearborn laboratories, prescribes the treatment and supervises the installation of the feeding equipment to give you full protection against shutdowns due to improperly conditioned water.

DEARBORN OFFICES THROUGHOUT THE COUNTRY

There is a Dearborn Engineer nearby to call on you. He is available for emergency assistance . . . or he will perform all of the six services enumerated above and essential to a thoroughly rounded boiler water engineering service. Call your nearby Dearborn office or write to us direct. Dearborn Chemical Company, Department F, 310 S. Michigan Avenue, Chicago 4, Illinois.

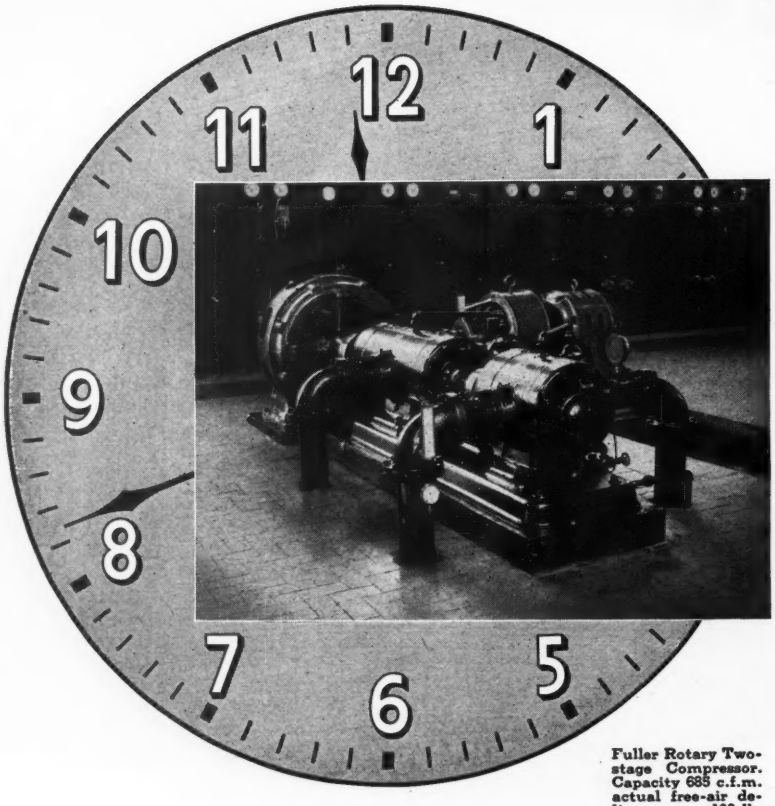


SEND FOR THE DEARBORN ENGINEER

Dearborn
TRADE MARK REGISTERED

BOILER WATER TREATMENT AND SERVICE

[For Victory, Buy United States War Bonds and Stamps]



Fuller Rotary Two-stage Compressor. Capacity 685 c.f.m. actual free-air delivery. 100-lb. pressure.

'Round the Clock Performance . . . Fuller Rotaries Give it to You

'Round the clock, 24 hours, day in and day out service with comparatively little shut-down or maintenance expense. That's why plant superintendents and maintenance men like Fuller Rotaries.

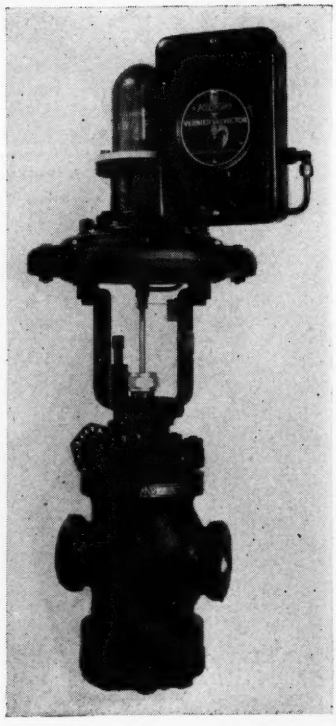
Performance records show they're truly the economical unit to install . . . in a foundry $3.90 for repairs in three years; in a patent fastener plant, four years' operation: "It has run 23 hours per day almost continuously and has given no trouble." Not a cent was spent for repairs during these four years.

FULLER ROTARY COMPRESSORS AND VACUUM PUMPS — BUILT FOR CAPACITIES TO 1800 C.F.M. PRESSURES TO 125-LB. VACUUMS TO 29.90-IN. REFERRED TO 30-IN. BAROMETER

Repeat orders also tell a conclusive story. A steel company purchased its first Fuller in 1939 and to date has installed 14 machines. An oil company has purchased 31, a cement company 28, machinery manufacturer 27, soap manufacturer 17.

Get acquainted with Fullers. Write for new Bulletin C-5 . . . it's yours for the asking.

FULLER COMPANY
CATASAUQUA—PENNSYLVANIA
CHICAGO, 3 Marquette Bldg. WASHINGTON, 5, D.C. Colorado Bldg. SAN FRANCISCO, 4 Chancery Bldg.

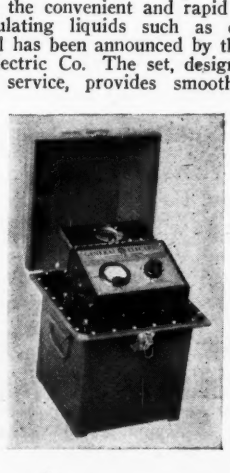


Continuing the same operating principles which have been used in older designs of the Vernier Valvactor, the new construction involves a completely different arrangement of the actuating elements. New ease and range of adjustment, especially for duplexing and sequencing, and new snap action, for relay service or step sequencing of valves or damper motors, are provided by new, convenient zero and range adjustments. New ease of reversal is provided, without change of parts or piping.

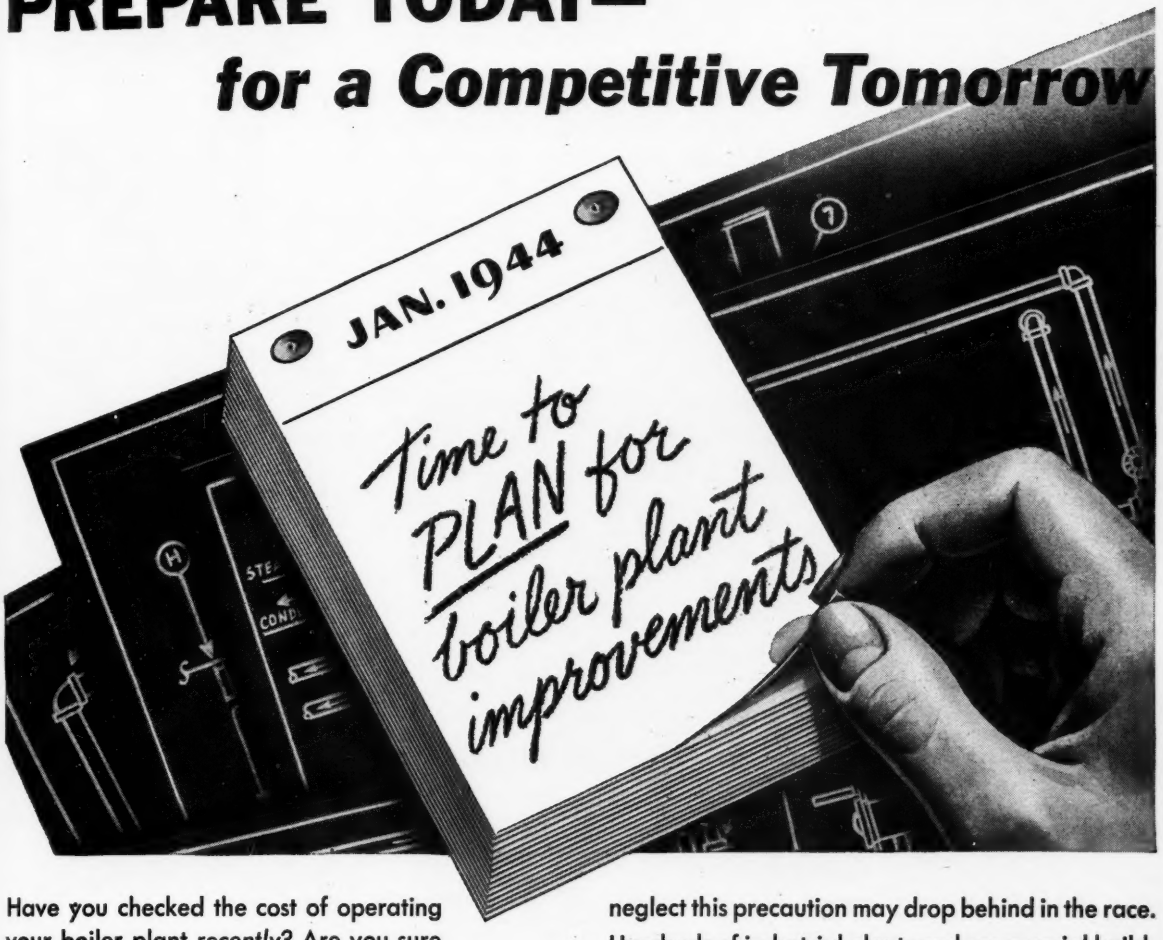
The new unit retains the relay action. Flexure type bearings, in place of pivots, eliminate the effects of mechanical vibration, without loss of sensitivity. Finally, although the Vernier Valvactor retains the same general external appearance, new ruggedness has been provided for it by a heavier metal case.

30,000-v Portable Oil Tester

An improved 30,000-v portable test set for the convenient and rapid testing of insulating liquids such as oil and Pyranol has been announced by the General Electric Co. The set, designed for indoor service, provides smoothly va-



PREPARE TODAY—
for a Competitive Tomorrow



Have you checked the cost of operating your boiler plant *recently*? Are you sure that it is producing each pound of steam at the lowest possible cost?

Post war must mean competition, when your industrial life will depend on your plant's ability to manufacture the best product at the lowest cost. Remember that *steam* is one of your important raw materials. Make that check of your steam costs right away and compile specifications for any improvements which may be indicated. Plants which neglect this precaution may drop behind in the race.

Hundreds of industrial plants and commercial buildings are already benefiting from low cost steam production with TODD combustion equipment. *Are you?* Plant managers who investigate and plan their requirements now will be ready to take advantage of the first opportunity to secure TODD liquid or gaseous fuel burners.

So, prepare today for a competitive tomorrow! TODD will be glad to aid you with an impartial survey of your boiler plant.

ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

riable test voltage from 0 to 30,000 v on single-phase, 115- or 230-v, 25- or 60-cycle circuits.

This portable tester can be used to advantage in industrial plants, central stations, substations, and wherever frequent oil testing is required, saving both time and expense in checking the proper dielectric strength of insulating liquids.

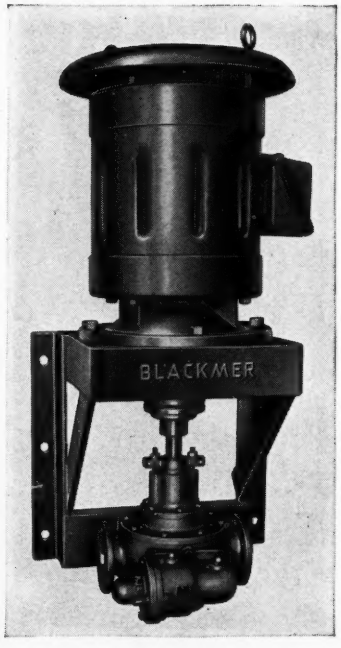
The tester combines in a single unit a step-up transformer, a potentiometer which gradually raises the test voltage, a voltmeter to measure breakdown values, an automatic circuit breaker, and an oil testing receptacle. The control panel is inclined toward the operator, enabling him to read the voltmeter easily and accurately. As soon as the test sample breaks down, the low-voltage breaker automatically opens the circuit, preventing continuation of the arc and burning of the electrodes. Complete instructions for operation are included on the surface of the control panel. The oil testing receptacle is located at the rear of the control panel under a hinged safety guard with a glass window.

The equipment, enclosed in an attractively styled steel case, weighs 80 lb. A hinged cover protects the control equipment and testing receptacle.

Marine Type Rotary Pump

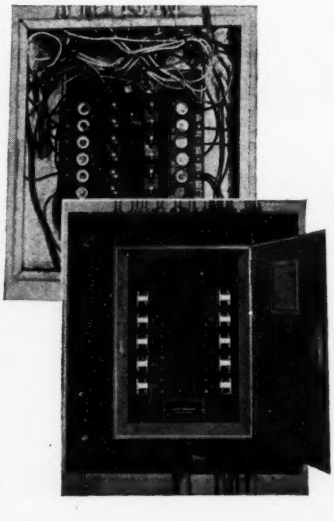
SPECIFICATIONS covering the design and operation of a new marine type rotary pumping unit with built-in relief valve, for handling Navy lube oil, have been released by the Blackmer Pump Co., Grand Rapids, Mich.

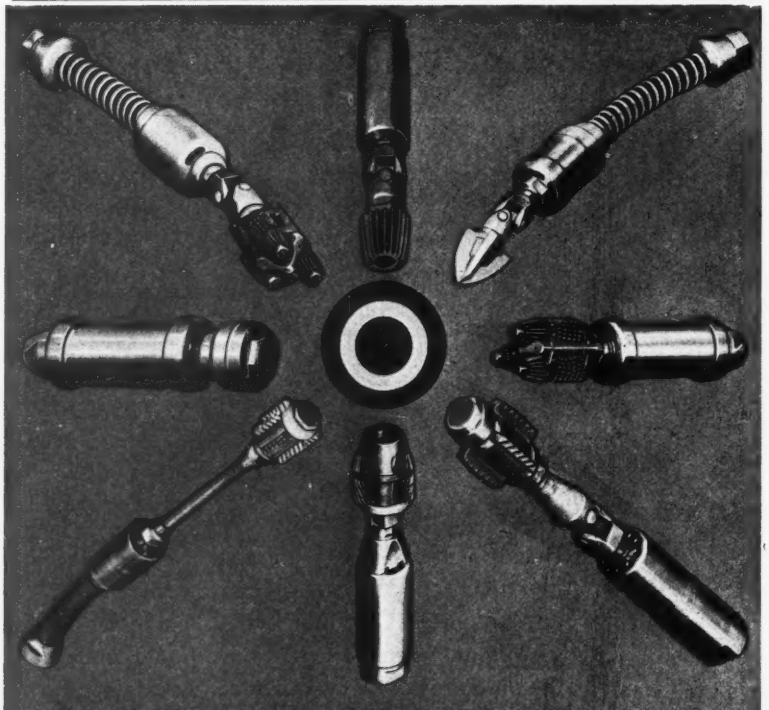
This unit, which operates on the bucket design (swinging vane principle), has a capacity of 50 gpm at a discharge pressure of 20 psi and is direct connected by means of a flexible coupling to a 3-hp motor which drives the pump at 870 rpm. The bearings are internal antifriction type, a split gland is used for ease in repacking. The motor is supported by a bracket or shelf, made of welded steel plate and bolted to a bulkhead. This type of mounting should have many applications in industrial and processing plants, and as original equipment on certain types of liquid processing machinery.



Multi-breaker Convertible Panel Plan

PLANT ELECTRICIANS, compelled to overload old style panelboards in the rush to meet war production demands, should be interested in the Multi-breaker Convertible Panel Plan developed by Square D Co. engineers. The plan provides for the complete conversion of obsoleted fusible panelboards to circuit breakers with considerable increase in the number of cir-





YOU CAN KEEP UP-KEEP DOWN WITH WILSON TUBE CLEANERS

Today, more than ever before, it is essential that boilers—like all other mechanical equipment—are maintained at maximum efficiency. Shutdowns for tube cleaning reduce plant production and improperly cleaned tubes necessitate more frequent cleanings. So, whenever a boiler *must* be cleaned it is sound business to always use a tube cleaner which operates at maximum efficiency and which does a *rapid* and *thorough* cleaning job. This will reduce the number of cleanings per year, will keep up-keep down and will increase production.

Wilson Tube Cleaners clean straight or curved ferrous or non-ferrous tubes of large or small diameter faster, better and more economically because they have more speed, more power and more efficiency built into them.

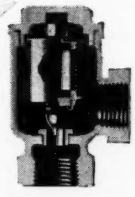
Write for the name of our representative nearest to you, or ask for a copy of our NEW 40-page catalog which fully describes and illustrates the complete line of Wilson tube cleaning equipment.

INVEST IN AMERICA! BUY WAR BONDS AND STAMPS!

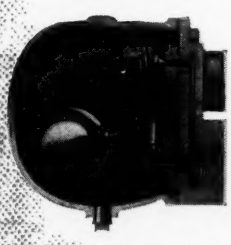
THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
THE WILSON BUILDING
21-11 44TH AVE. LONG ISLAND CITY, N.Y.

The Skunk under the Barn

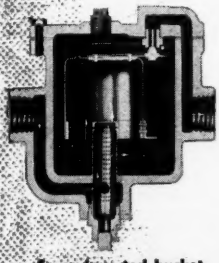
in the Steam-using Industries



Sarco No. 9 thermostatic steam trap



Sarco float-thermostatic steam trap



Sarco inverted bucket steam trap

Sarco No. 87 steam trap-control

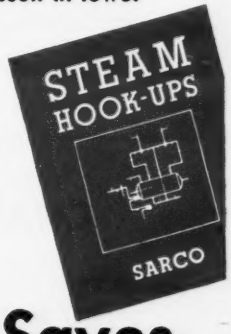
You can't see condensate in a steam coil, or a supply line. Unfortunately, you can't smell it either, but the steam engineer in your plant can tell you about where it is and how it slows up your production.

Given the right tools, this "skunk under the barn" can be completely eliminated from your plant in a few hours. The tools consist of small, inexpensive steam traps that can be slipped into the lines like a coupling or an elbow, without necessitating any shut down.

The results are frequently phenomenal. Right now the increase in production and decrease in rejects are the big things. In some plants they make unnecessary new boilers, new steam lines, or new plant additions. Sarco makes four distinct types of steam traps to meet all the varying conditions under which condensate must be drained and air removed from steam coils, jackets, rotating drums or heating surface. Let the Sarco man advise you.

Production Improvement is Post-War Planning. Anything along these lines that you do to increase your production now will result in lower costs per unit and higher quality of production in your post-war output.

The Sarco Hook-Up Book for steam engineers gives specific recommendations on many of these ideas, together with computation tables and a description of Sarco products.



SARCO COMPANY, INC.
475 FIFTH AVENUE
NEW YORK 17, N. Y.

Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO

15

PTP
COLD DRAWN
SEAMLESS
STEEL TUBES
ASTM and NAVY
SPECIFICATIONS
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CHANGE OF ADDRESS

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POWER PLANT ENGINEERING

cuits, as well as in the circuits and mains capacities.

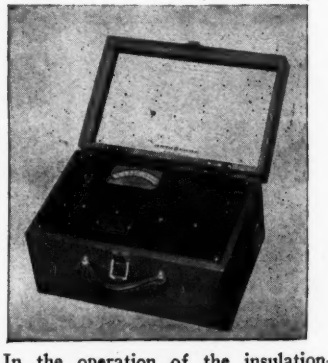
In some cases reported by the company's field engineers, the capacity of existing panelboards has been increased as much as 400 per cent but the average increase is between 50 per cent and 100 per cent. Besides utilizing the installed box and conduit, thus reducing the use of critical materials, labor costs and change-over time, such installations drastically reduce the heating which accompanies overloading and the resultant waste of power.

Under the Square D Plan, the conversion is relatively simple. The old trim and interior are removed from the box and the existing wiring pulled out if it cannot be utilized. By employing thin-wall wire, the existing conduit may be wholly or partially used. The ingeniously designed trim completes the new installation, as illustrated in the accompanying photograph.

Electronic Insulation-Resistance Meter

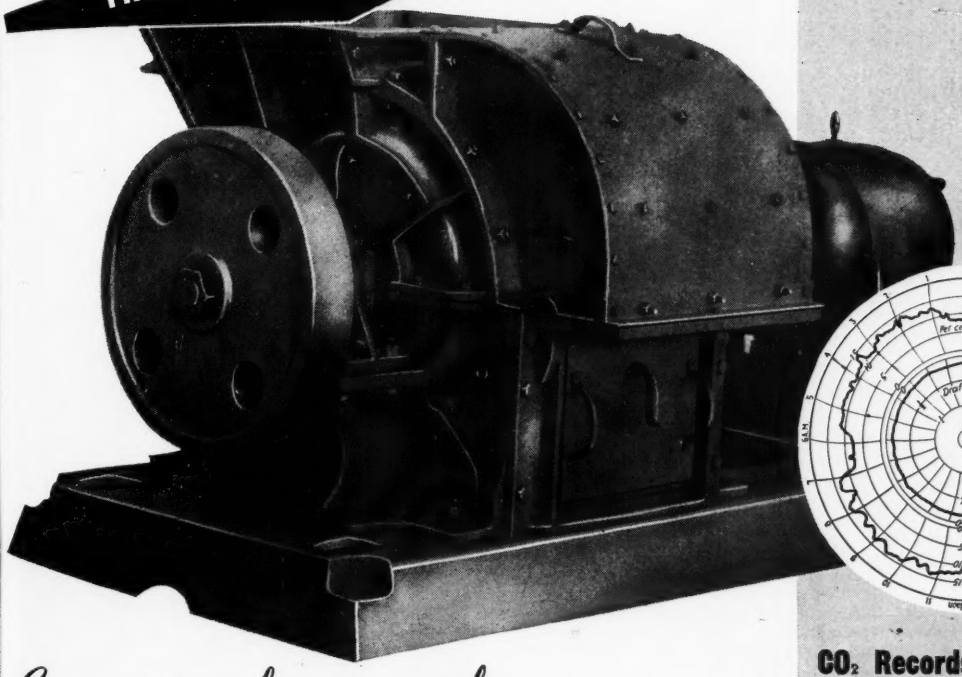
A NEW ELECTRONIC insulation-resistance meter for measuring the resistance of insulation in apparatus during the manufacturing process, thus revealing imperfections before the product leaves the factory, has been announced by the Special Products division of the General Electric Co. The instrument is also desirable for checking the condition of insulation of apparatus in service, and for use in the laboratory for rapidly testing a wide range of production or experimental samples of insulating material.

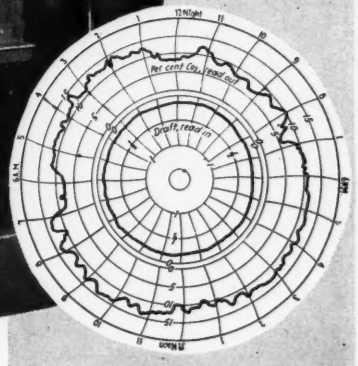
The instrument consists of a conventional electronic rectifier, a Thyrite bridge circuit, and an electron-tube voltmeter. It is available in two types. One type has a scale calibrated from 1 to 50 megohms and measures resistance at 500 v d-c; the other type has a 0 to 20,000 megohm total range and measures resistance over four different resistance intervals—from 0-5 megohms at 0-250 v d-c and 5-200, 50-2000 and 500-20,000 megohms at 500 v d-c. Any range may be quickly selected by a panel-mounted rotary switch.



In the operation of the insulation-resistance meter, which can be used wherever 115-v, 60-cycle current is available, the measuring leads from the instrument are connected to the apparatus or material to be tested. The scale-range selector switch is turned to the lowest range, and the power switch is turned on. If necessary, the selector switch is turned to successively higher ranges until the pointer of the illuminated scale is in the center portion of the scale. The resistance of the material under test is read directly in megohms. The test voltage is

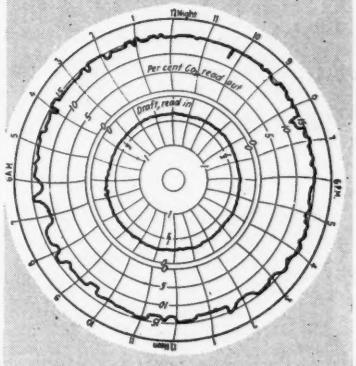
PROPERLY SIZED COAL... A "MUST" FOR THRIFTY BOILER OPERATION





CO_2 Records Show Need of Coal Sizing

The sizing of coal and its relation to ashpit losses is illustrated by the two CO_2 Charts herewith. Above shows what happens with poorly prepared coal. Below shows uniform CO_2 achieved through the installation of a coal crusher for better sizing.



Get more steam from your coal...

THE *American Crusher* WAY

IN line with the nation's program to conserve vital fuel supply, it's both patriotic and sensible to prepare coal for better sizing. This preparation results in a higher and more constant CO_2 reading—reduces the carbon content of the ash—makes your coal dollars produce more steam.

The experience of Bemis Bros. Bag Co., John Morrell & Co., Central Illinois Light Co. and scores of other plants is that AMERICAN Crushers — used in either stoker or pulverized coal burning—provide the proper coal preparation needed today for thrifty boiler operation. Many reports show that AMERICANS crush the coal exactly as required for top combustion efficiency, and at the extremely low crushing cost of *less than one cent a ton for all charges.*

The AMERICAN Rolling Ring Crusher, Type S, pictured above, has set new standards for efficient fuel sizing and trouble-free crusher operation through the use of heavy steel ribbed housing, anti-friction bearings, adjustable grinding plate, reversible manganese steel shredder rings which *split* coal instead of crushing it.

Ask our engineer to study your particular boiler plant operating conditions and offer suggestions for better sizing, lower steam costs. Write for descriptive bulletin on AMERICAN Crushers.

AMERICAN PULVERIZER COMPANY, 1429 Macklind Ave., St. Louis, Mo.

The "S" Type Is the Improved All-Steel AMERICAN RING CRUSHER

COLOR CLEAR OIL IS CLEAN OIL

● Any substance in lubricating oil that darkens and changes the color of the oil detracts from its lubricating efficiency. The change in color may result from acids, soluble sludges and minute abrasives, any of which may cause serious damage to the bearings or other moving parts.

By continuously removing all types of contamination a Honan-Crane "Continuous" Oil Purifier will keep your lubricating oil color clear which is a positive indication that the oil has the highest lubricating efficiency possible to maintain.

Illustration above is an unretouched photograph of the same lubricating oil. Bottle at left is the oil as it came out of the operating engine. Bottle at right is the oil after purification through a Honan-Crane "Continuous" Oil Purifier.

Write today for complete information on the purification of any type of lubricating oil.

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RESIDENT ENGINEERS IN PRINCIPAL CITIES

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The most remarkable tool ever invented

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THE ALLPAX GASKET CUTTER

Manufactured by

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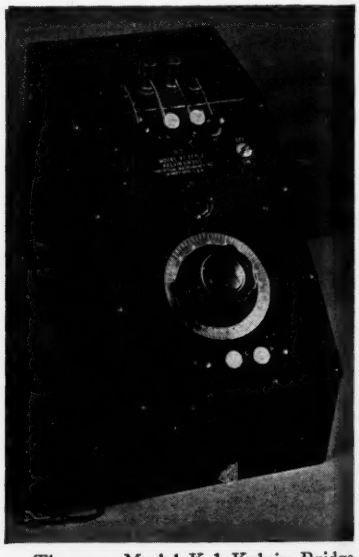
Distributors everywhere ***Mamaroneck, N. Y.***

regulated to 500 v d-c by the Thyrite bridge, even though the 60-cycle line voltage is fluctuating.

The complete instrument is small, light in weight, and economical to operate. It is enclosed in an attractive, portable walnut case, the cover of which may be removed so that the instrument can be placed on a shelf or stand in full view of the operator. In addition, the well-illuminated dial permits the scales to be read easily even in poorly lighted locations.

New Kelvin Bridge

SEVERAL noteworthy innovations are presented in the Model K-1 Kelvin Bridge just announced by Industrial Instruments, Inc., Jersey City, N. J. First, the bridge source voltage is 60 cycle a-c instead of the usual d-c. Second, an electron-ray null indicator has been substituted for the conventional galvanometer. Third, the instrument can be operated by unskilled personnel at high-speeds—up to several hundred tests per hour with suitable test fixtures. Fourth, the entire equipment is completely self-contained in a single cabinet, requiring no outside accessories such as batteries or galvanometers. Fifth, operation is reduced to utmost simplicity and directness, since measurements are obtained by the rotation of a single dial directly calibrated in resistance, the dial readings being multiplied by a factor determined from the setting of the standard resistance switch.

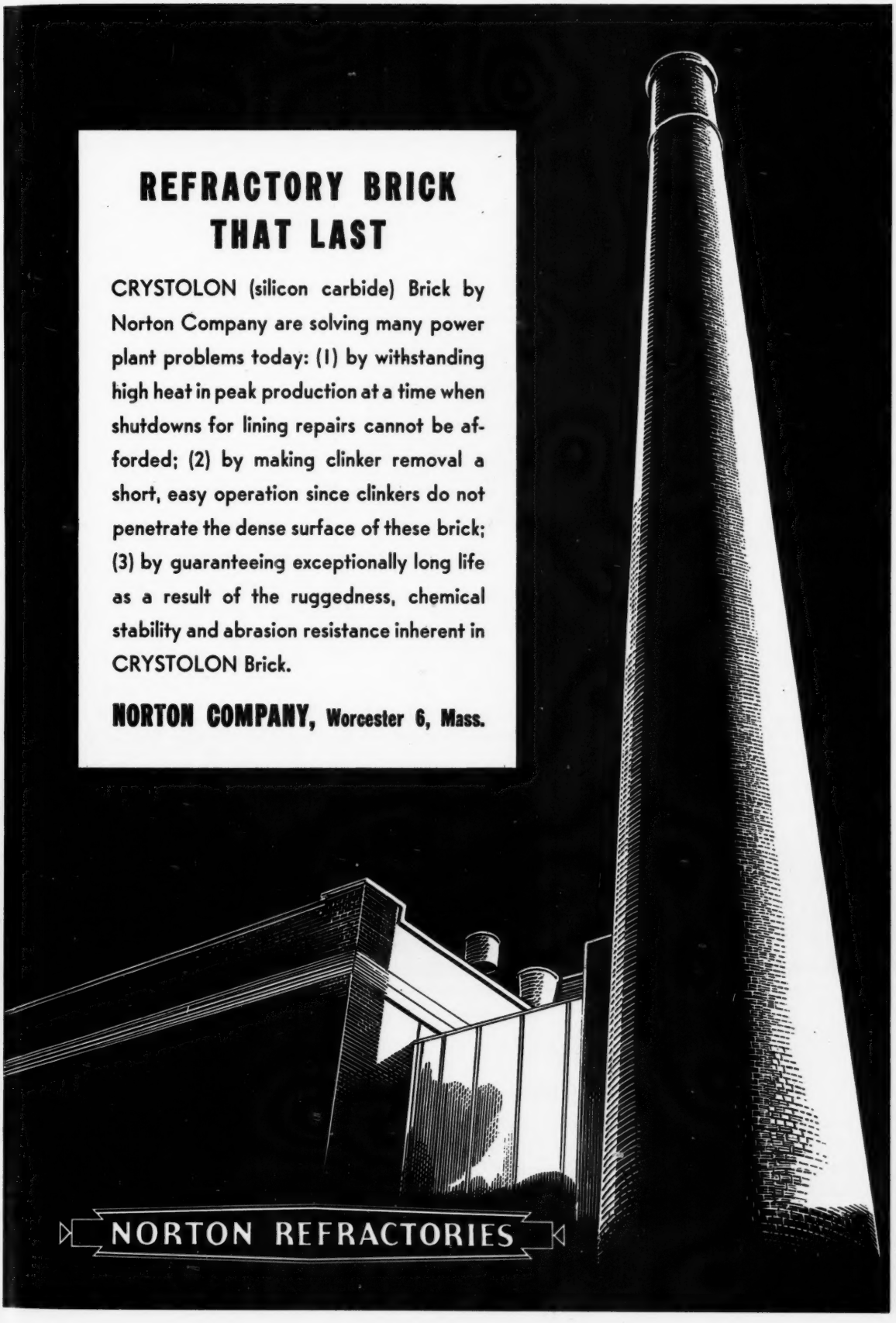


The new Model K-1 Kelvin Bridge is particularly useful for routine measurements in production, or again in the laboratory on low-resistance elements such as fuses, fuse clips, switch contacts, wire, bonds and other similar items. In addition to extreme ruggedness and high-speed operation, the instrument is characterized by a source voltage of only 0.05, which means no appreciable heating of any resistor under test. The overall accuracy is within plus-minus 2 per cent except for resistance values below 0.0005 ohm. The accuracy at the lowest resistance that can be measured, 0.0001 ohm, is within plus-minus 5 per cent. The standard resistor decade DR-20 supplied with this instrument has 10 settings of from 0.001 to 1.0.

REFRACTORY BRICK THAT LAST

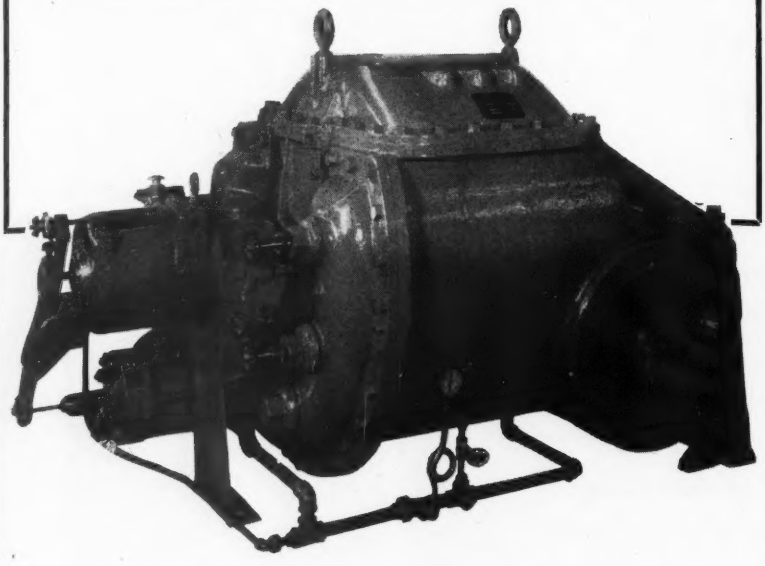
CRYSTOLON (silicon carbide) Brick by Norton Company are solving many power plant problems today: (1) by withstanding high heat in peak production at a time when shutdowns for lining repairs cannot be afforded; (2) by making clinker removal a short, easy operation since clinkers do not penetrate the dense surface of these brick; (3) by guaranteeing exceptionally long life as a result of the ruggedness, chemical stability and abrasion resistance inherent in CRYSTOLON Brick.

NORTON COMPANY, Worcester 6, Mass.



MURRAY TYPE UV

Multi-stage Mechanical Drive Turbine



The Murray "UV" Multi-stage Turbine parallels the design of the Type "U" Single Stage Turbine. It has the same unique and patented arrangement of the casing which is split horizontally well above the shaft center line. This construction provides a longer steam ring with greater nozzle area and larger steam inlet size, larger exhaust opening, additional hand valves and improved efficiency.

View shows the unit equipped with mechanical shaft type main speed governor and hand speed changer. Also shown is the standard center line exhaust end support and flexible steam end support.

The "UV" turbine can also be provided with oil relay governor—either of the constant or variable speed type; as well as extraction or extraction mixed pressure gear. Write for descriptive bulletin.

BOILERS · TURBINES · ENGINES

MURRAY
IRON WORKS COMPANY
INCORPORATED 1870
BURLINGTON IOWA

OPPORTUNITY

Boiler Feed Water Men

Exceptional Opportunity For Experienced men. Chemical or Mechanical background. Permanent Post-War Program, Good Salaries and Advancement. Principal Industrial Cities.

Address Box No. 1432, Power Plant Engineering,
420 Lexington Ave., New York 17, N. Y.

Synthetic Shellac

DEVELOPMENT of synthetic shellac has been announced by the Arthur D. Little laboratories. The new product will relieve the serious shortage of natural shellac, which is normally imported from India, but since Pearl Harbor has not been adequately available, even for essential uses. C. G. Harford, the inventor, stated that extensive practical experience reveals the new shellac as essentially a duplicate of the natural product, but surpassing it in some properties, such as adhesion to metal as well as wood and subsequent resistance to water. The synthetic shellac is made from available domestic materials. Mr. Harford previously developed processes for the manufacture of one of these raw materials, the corn protein zein, and has developed a number of new products in his special field of protective coatings.

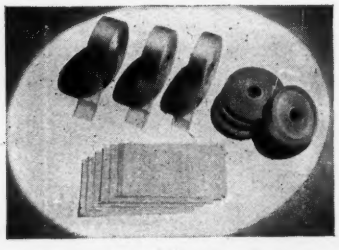
The new shellac is being manufactured under the name "Zinlac" by William Zinsser and Co., New York, and is available for essential wartime applications. It is being used now in shipbuilding, life rafts, communications, gas masks, fuses and other military products.

Natural shellac, the hardened secretion of an Indian insect, has been virtually unique in its combination of hardness, wear resistance, speedy drying and solubility in cheap solvents. These qualities, which prompted its use in such diverse fields as floor protection and fine furniture finishing, had not previously been duplicated despite years of effort both here and abroad.

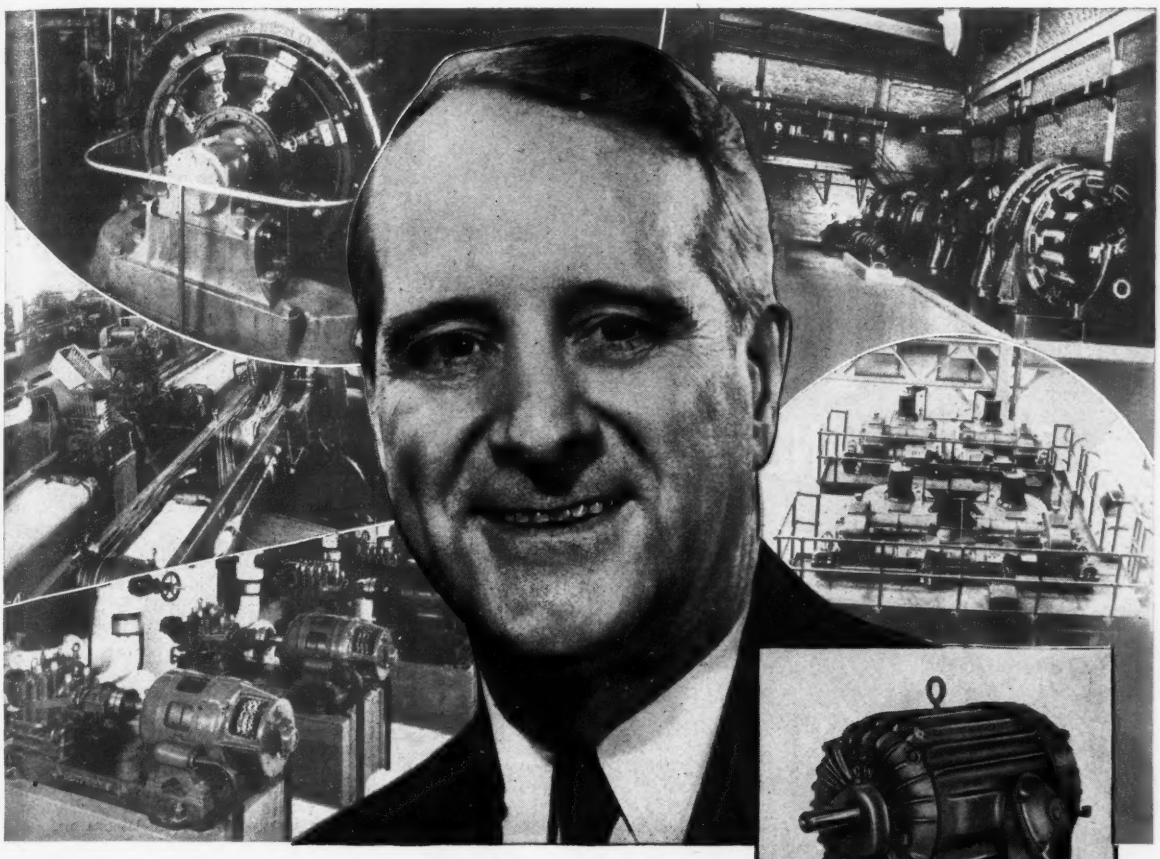
G.E. Announces "Lectrofilm"

LECTROFILM, a new synthetic dielectric material for capacitors, developed after several years of General Electric laboratory research, and made of materials available in the United States, has been announced by the company.

Lectrofilm, the development of which was hastened by the growing shortage of high-grade mica, can be best applied to the manufacture of most radio-frequency-blocking and by-pass, fixed capacitors used in communications and other electronic equipment. The new product has a greater combination of desirable properties than was previously available in any one dielectric material. It is available in both rolls and sheets and can be used in present capacitor production lines with very little change in equipment or method of manufacture.



In addition, lectrofilm's strength and flexibility make it well-suited to automatic methods of manufacture. The careful control used in its production, together with its chemical stability, assure uniform properties and freedom from defects. Furthermore, it requires little grading or sorting before being placed into a capacitor production line. Com-



A Partner Worth Having

YES, THE CROCKER-WHEELER field engineer has an ear to the ground and an eye to the future. Not a miracle man, but thoroughly educated in engineering and with years of experience in the application of motors and generators.

Some men on our staff took part in the design and installation of the first steel mill motor . . . others installed the first motors geared to machine tools . . . still others worked on the first motor for printing presses, the first for pumps.

One of our men will be glad to discuss with you any motor or generator problem. While your plans are still in the blueprint stage is the time when his assistance can be most worthwhile. Write, wire or call on us at our nearest office.

JOSHUA HENDY IRON WORKS

CROCKER-WHEELER DIVISION

ESTABLISHED 1856

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CROCKER-WHEELER — Trade Mark Reg. U. S. Pat. Off. — Motors - Generators

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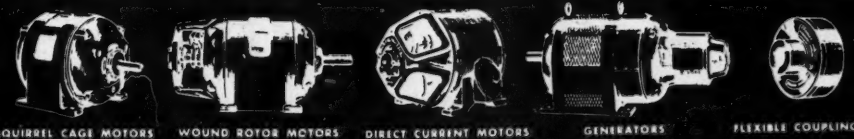
Crocker-Wheeler Products



SQUIRREL CAGE MOTORS — WOUND ROTOR MOTORS — DIRECT CURRENT MOTORS — GENERATORS — FLEXIBLE COUPLINGS

Since 1910

Dependable, powerful tube cleaners for every power plant requirement. One-man operation saves time and labor.

The ROTO Company 145 Sussex Ave., Newark 1, N. J.

BACK THE ATTACK

WITH WAR BONDS

pared with other dielectrics, lectrofilm requires less inspection and, properly applied, its use will cut down the number of finished capacitors that are rejected in test, thereby reducing the amount of labor and increasing production with present facilities.

The development of lectrofilm is considered by many to be the most outstanding achievement affecting the manufacture of capacitors in recent years. With the recent War Production Board edict limiting the use of prime mica, the use of lectrofilm attains further importance.

OBITUARIES

David B. Piersen

DAVID B. PIERSEN, Chairman of the Board of Directors of the Stephens-Adamson Mfg. Co., Aurora, Ill., died on November 29, 1943, of a heart attack at the age of sixty-three.

Mr. Piersen started with Stephens-Adamson Mfg. Co. when that company was founded in 1900. Served as sales manager, secretary and vice-president before being elected president in 1914. Since 1934 he had been active in sales and administration as Chairman of the Board.

Some of his other activities included: Treasurer of the Aurora Sanitary District, Director of Western United Gas & Electric Co., past president of the Aurora Country Club, past president Aurora Chamber of Commerce, member of Aurora Commandery No. 22, Knights Templar, Medinah Shrine, Chicago, Aurora Lodge No. 705, B. P. O. Elks, the Union League Clubs of Aurora and Chicago, and other organizations; four terms as president of the Fox Valley Manufacturers' Association, four terms as president of the Associated Employers of Illinois, three terms as director of the Illinois Manufacturers' Association and a term as president of the Conveyors' Association.

He was equally active in the church life of the community, being a member of the Trinity Episcopal Church, a member of the standing committee of the Episcopal diocese of Chicago, and a member of the diocesan council of the Episcopal church.

Hugh J. Homewood

HUGH J. HOMEWOOD, treasurer of Gisholt Machine Co., Madison, Wis., and affiliated with the company organization for nearly 20 years, died at his home on November 7 at the age of 49.

Prior to his election as treasurer of the firm in 1940 he had served in various capacities culminating in his appointment as chief accountant and office manager—which positions he held for 10 years.

MANUFACTURERS' PERSONALS

Appointment has been announced of two new managers in the Industry Department of the Westinghouse Electric and Manufacturing Co. They are C. F. Lloyd, manager of the General Contract Department, and Tomlinson Fort, manager of the Central Station Department. Headquarters of both men will remain at the East Pittsburgh Plant. Since February 15, 1940, Mr. Lloyd has been manager of the

WE REPEAT . . .

In Many Cases, It's Cheaper To Generate Your Own Electric Power Than To Buy It.

A Power Tale of Four Cities
SKINNER ENGINE COMPANY ERIE, PA.
Supplying Dependable, Economical ELECTRIC POWER for Industry
SKINNER "UNIVERSAL UNAFLOW" STEAM ENGINES
SKINNER ENGINE COMPANY ERIE, PA.
MORE PROOF
SKINNER ENGINE COMPANY ERIE, PA.
These Companies Don't Buy Electric Power They Generate Their Own, with SKINNER "Universal Unaflow" STEAM ENGINES
SKINNER ENGINE COMPANY ERIE, PA.
Practically Every Industry
SKINNER "UNIVERSAL UNAFLOW STEAM ENGINES
SKINNER ENGINE COMPANY ERIE, PA.

HERE'S PROOF . . .

DURING the past few months the accompanying advertisements have appeared in various technical publications. These have shown some of the many industrial plants and institutions in which large savings have been made, in comparison with the cost of purchased power, by generating electric power with "Universal Unaflow" steam engines, and utilizing the exhaust steam for building heating or process purposes.

If you are now purchasing power and are using low pressure steam, during the heating season or the year 'round, for building heat or processing, consult with us. We can undoubtedly cite similar cases in your particular industry where Skinner "Universal Unaflow" engines have paid for themselves out of savings. Our Research and Engineering Departments are available now to discuss your power costs for the future.

Some Users of "UNIVERSAL UNAFLOW" Engines

Hotels, Clubs	Food Products	Printing, Publishing
Schools and Colleges	Ice & Cold Storage	Paper, Paperboard
Hospitals, Homes	Mining	Laundries, Cleaners
Public Institutions	Chemical, Ordnance	Oil Refineries
Department Stores	Drugs and Soaps	Stone and Brick
Office Buildings	Machinery Mfrs.	Gas Plants
Railroads	Textiles	Rubber
Meat Packing	Leather Products	Glass
Dairies	Furniture & Woodworking	Bakeries
Breweries	Cotton Oil Mills, Gins	Tobacco
	Municipal Water & Electric Plants	

ARMY E NAVY

Back The Attack
Buy War Bonds

For Over 75 Years, Doing One Thing Well—Building Steam Engines

SKINNER ENGINE COMPANY ERIE, PA.

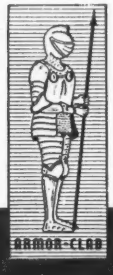
WANT TO ADD 50% to 300% TO FURNACE WALL LIFE?

Tests Prove Ability of

ARMOR-CLAD

To Prevent Flame Penetration and Slag Accumulation

The picture above tells the performance story of firebrick coated with ARMOR-CLAD "Armorite" 300. After the coatings had been set by bringing the treated brick up to more than 3000 deg. F., tests were made by concentrating an acetylene torch flame on a single spot for 3 minutes. The coating showed no damage. See illustration above. A similar test was made on the uncoated side of the brick—which started to melt and run after only **5 seconds** exposure.

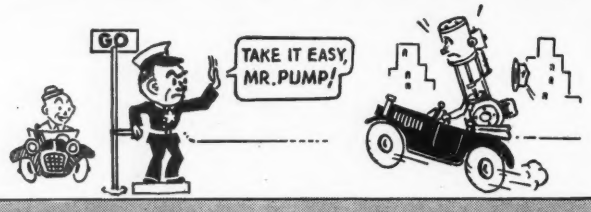


ARMOR-CLAD Monolithic Coatings for furnaces stand up in toughest service. They prevent penetrations of flame, vapors, and slag accumulations which destroy refractory walls. Many users report furnace wall life is increased 50 to 300% with Armor-Clad Coatings.

ARMOR-CLAD Coatings are adapted for all types of furnaces and all types of fuels. Easily applied by brush or spray gun. Send for descriptive booklet and sample of firebrick coated with Armor-Clad.

ARMOR-CLAD COMPANY

39 Hyatt Ave., Newark, N. J.



COMBINATION

NON-TILT, NON-SLIP VALVES

Protect Pumps against wasteful "over-speeding"

The tilting action of some reciprocating pump valves causes the seat to wear unevenly—which means the pump has to work faster and faster to carry its load.

COMBINATION Pump Valves enable you to get theoretical capacity out of your pumps without racing and wasting valuable steam. They prevent tilting and consequent pump slippage because they lift straight. They save on repair bills, too, because their seat, stud and springs are made of long-wearing Phosphor Bronze.

These improved pump valves match the fine performance of COMBINATION Silent Check Valves. Ask for descriptive folder with dimensions, prices and further information.

For Boiler Feed Vacuum, Condenser General Service

COMBINATION PUMP VALVE CO.

846 Wiota Street, Philadelphia, Pa.

Central Station and Transportation Departments. Mr. Fort has been assistant manager of the same department.

After 45 yr. service with General Electric, Walter L. Harraden, one of the company's street lighting pioneers, has retired. Well known in utility circles, Mr. Harraden is the co-inventor, with C. A. B. Halvorson, of the ornamental luminous arc lamp widely used for street lighting during 1914-1920, and still operating on many business streets. Since 1916 he has been engaged in promotional activities in the company's lighting division at Schenectady. Born in Lynn, Mass., Mr. Harraden was graduated from high school in 1897. He attended night classes in electricity while employed as a student engineer by G. E., and as an additional educational venture helped to organize night classes in electrical engineering at Lynn High School. In August, 1906, Mr. Harraden was sent to the Pacific Coast, where he was attached to the San Francisco Office, trouble-shooting on the great lighting systems along the Coast, and particularly at Portland, Oregon. This was the first installation of large-size rectifier systems for operating arc lamps. Previously, in 1904, he had installed the first luminous arc lamps in the world at Jackson, Michigan. This was a big step forward from the carbon arc lamp, and was followed by an installation in Marysville, Ohio, and other cities. After the coast venture he returned to Lynn and engineering work for 8 yr. In 1915 he was sent to the San Francisco Exposition with other lighting men. In September, 1916, he was transferred to Schenectady to the Lighting Division. It was here that his experience was first turned to commercial promotional work in the lighting field, a job he held until his retirement, effective November 5.

R. D. Ulrey of the Joshua Hendy Iron Works, Crocker-Wheeler Electric Division has been appointed manager of the new Los Angeles, California, office. This office, located in the Pacific Mutual Building, 523 West Sixth Street, will provide coverage for Southern California, Arizona and New Mexico.

Archie Chandler, vice president of the American Pulley Co., Philadelphia, has announced his retirement from active sales management of the company. Mr. Chandler will continue as vice president, but will return to his former home in San Francisco, where he will direct the company's sales and service on the West Coast. Frank E. Brown, for 15 years assistant sales manager, has been named to succeed Mr. Chandler as general sales manager.

Cochrane Steam Specialty Co., 80 Federal Street, Boston, Massachusetts, announce the addition of Joseph L. Dudley to their organization. Mr. Dudley was formerly associated with Jackson and Moreland Engineers and with Stone and Webster Engineering Corporation.

with the JOHNSON Electronic *DUO-STAT*

As outdoor temperatures vary, the Johnson Electronic Duo-Stat is the "go-between" that literally "changes the size of the heating system" so that indoor temperatures may be maintained automatically at a constant level without wasting time or fuel.

The temperature-sensitive elements are located on the outside of the building and on the heating system. By controlling the heat at its source, the Johnson Electronic Duo-Stat maintains the required temperature of the heating system at all times.

Johnson Electronic Duo-Stats may control automatic firing devices or a valve on the "street steam" main. In larger buildings, the heating system may be divided into zones, the number depending on use, occupancy, exposure and other factors. Each zone may be controlled separately at different temperature levels.

Whatever your temperature or air conditioning control problem . . . in industrial, commercial, institutional or office buildings . . . get in touch with the nearest Johnson office. A staff of trained installation men is located in each principal city.

FOR SPECIAL APPLICATIONS REMEMBER PNEUMATRONICS

Pneumatronics, developed by Johnson, is a combination of the best in electronic circuits, coupled with pneumatic temperature control equipment. Pneumatronic principles may be applied profitably to certain types of automatic temperature control problems in the industries and for the control of steam and hot water heating.

Johnson Electronic Duo-Stat, which is connected to resistance bulbs on the heating system and to a temperature-sensitive element on the outside of the building.

MORE AND MORE IN '44 BUY WAR BONDS

JOHNSON SERVICE COMPANY

MILWAUKEE 2, WISCONSIN

Temperature and Air Conditioning Control Equipment

Direct Branches in All Principal Cities

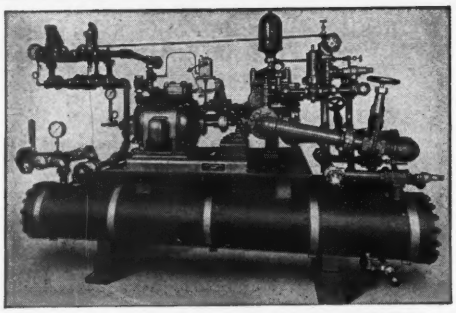
SWARTWOUT CONTROLS

increase the efficiency of your power plant—give you Safety, Low Maintenance *and* Consistent Performance.

WRITE FOR BULLETINS on the type of controls you require.

THE SWARTWOUT CO.
18511 Euclid Avenue, Cleveland 12, Ohio

Enco *Automatic* **OIL PUMPING AND HEATING SYSTEM**



COMPLETE
Every detail part is there, in a coordinated design, assembled, checked and tested . . . ready to run.

AUTOMATIC
The Enco Unit is fully automatic . . . and has a safety valve in front of every valve that can be closed against pressure. Single or duplicate pumps and heaters are used . . . interconnected for full capacity from either pump or heater.

SAVES TIME
Valuable time and money are saved because the Enco Unit IS a unit . . . complete . . . and can be put in service in a few hours.

SAVES TROUBLE
The engineering and troublesome selection of auxiliary equipment and connecting pipe are all done in the factory . . . cutting field work to the bone.

FREE BULLETINS OB-37 on oil burning, pumping and heating equipment. OB-38 Instruction book on the care and operation of oil-burner installations.

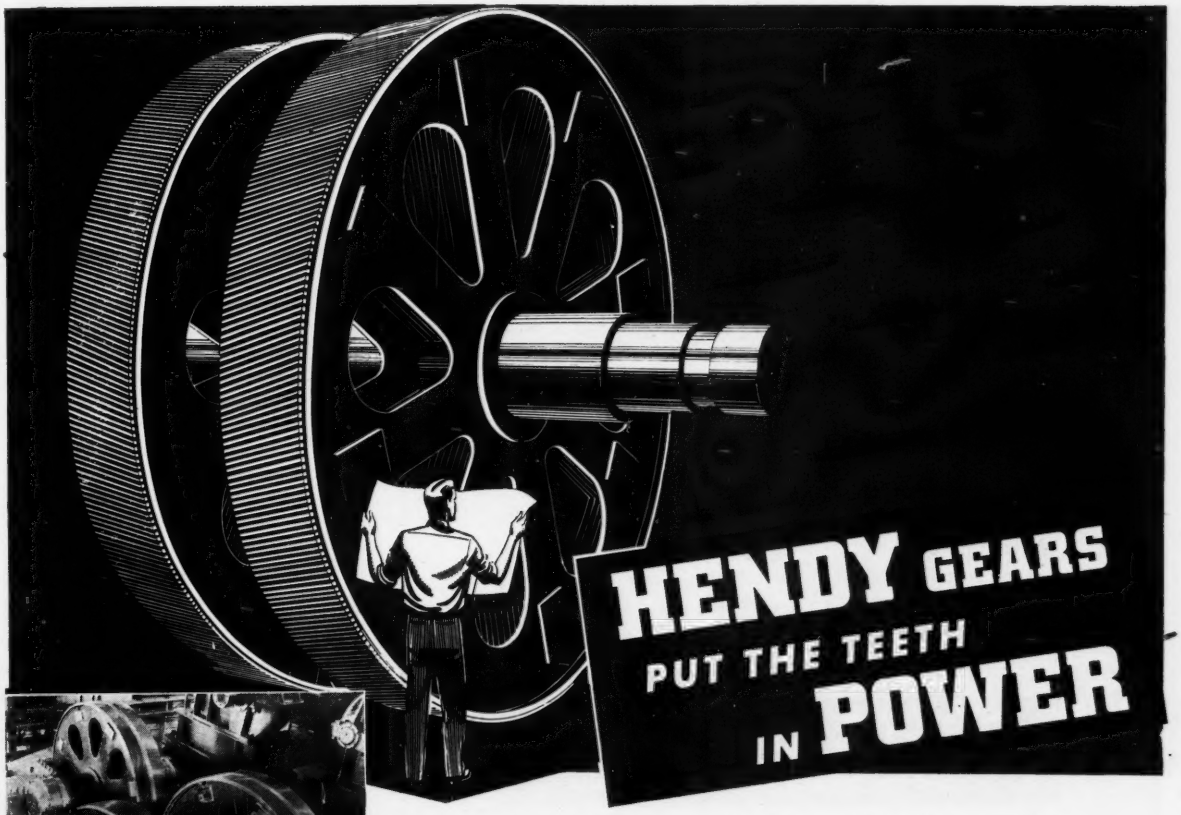
THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK, N.Y.

Fairbanks, Morse & Co. has recently announced the following changes in personnel:

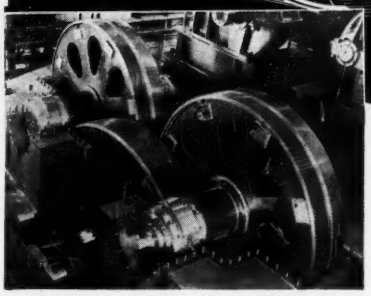
O. O. Lewis, formerly branch manager, Atlanta, Ga., has been promoted to the position of assistant general sales manager of the company, Chicago, Ill. V. O. Harkness, former manager of the company's branch at Dallas, Texas, has been appointed manager of the Diesel Engine Sales Division, Chicago. H. J. Renken, former manager of the Oil Field Division at Dallas, has now been made branch house manager of the company's Dallas, Texas, branch where he will also continue to serve as manager of the Oil Field Division in connection with his new duties. J. S. Peterson formerly scale department manager of the Cincinnati branch, has been promoted to the office of branch manager replacing the late Mr. Stanley Eaton. G. N. Van Epps, formerly manager of the Diesel Department, Chicago branch, has been promoted to manager of branch at Atlanta, Ga.

Wilbur H. Armacost has been elected vice president of Combustion Engineering Co., Inc., New York, to succeed the late F. H. Rosencrants in charge of marine activities of that company. He will also continue to supervise the design of industrial superheaters and economizers, as well as forced-circulation boilers, and will be responsible for the chemical recovery units and VU type steam generators. Mr. Armacost is a graduate in mechanical engineering of Armour Institute of Technology, 1916, and during the next few years held several positions in the field of research and power plant testing. In August 1920 he became associated with The Superheater Co. as designing engineer and in 1931 was promoted to chief engineer of its industrial department. Later he served as chief engineer of the superheater and economizer division of Combustion Engineering Co., then chief engineer of its marine department and in charge of the design of forced-circulation boilers.

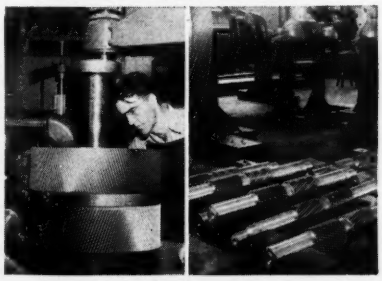
Otto de Lorenzi, for several years past assistant general sales manager of Combustion Engineering Co., has been appointed director of education of the company. In this capacity he will collaborate with engineering schools, technical associations and societies in the furtherance of technical educational matters, will supervise the preparation of certain technical data, and have charge of the company's student engineering courses. He will also continue his photographic research of furnace operation as at present, and to cooperate with the engineering department in the development of stokers. A graduate in mechanical engineering of Cornell University with the class of 1916, Mr. de Lorenzi has served in many departments of the company including tests, engineering, district engineer and as assistant chief engineer. He is the author of many technical papers and has given numer-



HENDY GEARS PUT THE TEETH IN POWER



Hendy engineers and builds a complete range of special speed reducers and speed increasers.



Small hobbing machine cutting 18.3 inch reduction gears for 300-K.W. turbo-generator. At *right*, assortment of pinions for various geared turbine units.

Hendy gears today are putting the "teeth" in the power that drives the greatest merchant fleet of all time—the American Merchant Marine—over all the oceans of the earth toward inevitable victory.

Soon Hendy gears will be available for rubber mills, paper mills, mines, factories, the countless industrial units that will rebuild the world of tomorrow. From new skill and increased capacity developed in war, Hendy will be able to supply a complete line of gears in all sizes up to 180" diameter and for any power capacity. High load capacity is a requirement of marine gears. Hendy industrial gears measure up fully to the standards set by Hendy marine gears.

JOSHUA HENDY Division

JOSHUA HENDY IRON WORKS

ESTABLISHED 1856

SUNNYVALE, CALIFORNIA

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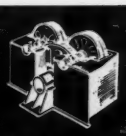
HENDY

TURBO-GENERATORS

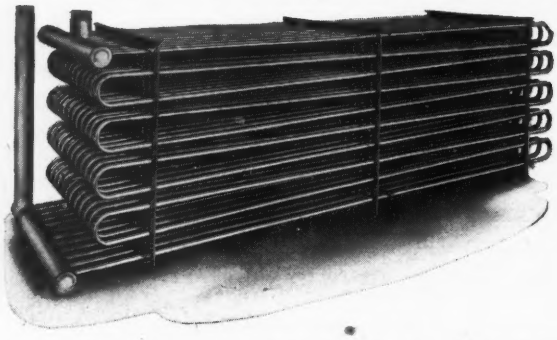


REDUCTION GEARS

STEAM TURBINES

DIESEL ENGINES

Another Heat Reclaiming Unit from Rempe



Copper Coils Welded into 4 In. Headers

UNIT is all copper including the headers and is 24 feet in length. Used for pre-heating processing water by submersion in concrete pit through which waste hot water is pumped . . . Rempe Coils and Bends are made from any material to customer's specifications. Write us about your needs.

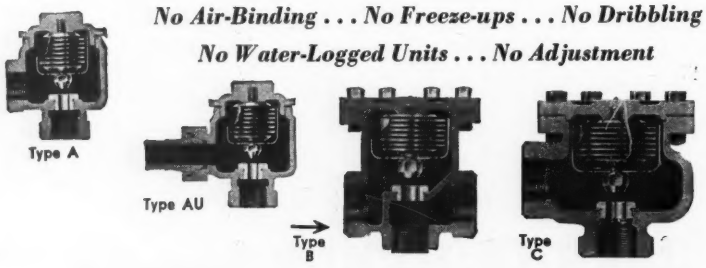
REMPE CO.
342 No. Sacramento Blvd., Chicago

★Enormous Water and Air Discharging Capacity

★Positive Intermittent Valve Action

No Air-Binding . . . No Freeze-ups . . . No Dribbling

No Water-Logged Units . . . No Adjustment



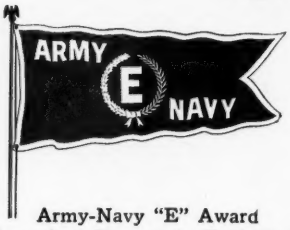
NICHOLSON *Thermostatic Industrial* TRAPS

Frequent intermittent discharge of condensate creates better circulation of steam in kettles, platens, driers, unit heaters and other equipment, thus inducing rapid and maximum heat transfer efficiency, and greatly increasing production. Bulletin No. 843 illustrates and describes all five types of Nicholson Thermostatic Traps. Sizes ¼" to 2". Pressures to 225 lbs.

W. H. NICHOLSON & CO., 160 OREGON ST., WILKES-BARRE, PA.
TRAPS ● *VALVES* ● *STEAM SPECIALTIES*

ous talks before engineering societies and student groups. In many of these talks he has made use of colored motion picture films to demonstrate his researches in the art of fuel burning and study of fuel-bed conditions as a basis of design. His selection as director of education is a logical sequence to this wide experience.

MANUFACTURERS' NEWS



Army-Navy "E" Award

Independent Pneumatic Tool Co.*
Aurora and Chicago, Ill.
Manhattan Rubber Mfg. Division
Raybestos-Manhattan, Inc.
Passaic, N. J.
Phelps Dodge Copper Products Corp.*
Habirshaw Div., Yonkers, N. Y.
Sarco Co., Inc.* New York, N. Y.

Maritime Commission "M" Award

Pottsville Castings & Machine Shops, Inc.
Sub. of Condenser Servings & Engineering Co., Inc., Hoboken, N. J.

*Star added for sustained high achievement in production of war equipment.

The Enterprise Engine & Foundry Co. of San Francisco announces the appointment of E. H. Davis as manager of the new Eastern District office opened at 44 Wall Street, New York City. Mr. Davis is well known in the Diesel engine field and has been prominently identified with many of the developments which have brought Diesel power into greater use in all spheres of power development. Mr. Davis will be assisted by an engineering staff composed of Robert Stickel, George Johnson, and Harry Huxford.

Kieley & Mueller, Inc., North Bergen, N. J., has appointed C. H. Stone & Co., 45 Arch Street, Boston, Mass., as exclusive representatives in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. The Stone organization will represent Kieley & Mueller, Inc., on its entire line of pressure regulating valves, back pressure valves, liquid level controls, strainers, steam traps, float valves, pump governors and power plant equipment for all industrial applications throughout the New England area.

Announcement has been made that two long established firms have now joined forces to mark a new source of supply for plumbing drains, marine fittings, and similar specialties. The new organization will be known as the Wade Manufacturing Co., Division of Woodruff & Edwards, Inc., with main offices and plant at Elgin, Ill. The Wade Manufacturing Co. has been a manufacturer of drains and similar equipment for more than 75 yr. Woodruff & Edwards, Inc., has had an equally long record in the production of fine quality castings. Mr. Norman B. Graham, who is managing the new enterprise, states that this combination of Wade experience and Woodruff

PREVENT DUST CONTAMINATING THE ATMOSPHERE

With a Thermix Ceramic Dust Collector on guard, not enough coarse, black, high-carbon dust can escape from your stacks to be objectionable. The small percentage of dust which may escape is so low in carbon and so extremely fine, that it is usually carried for miles before settling and, consequently, is not bothersome.

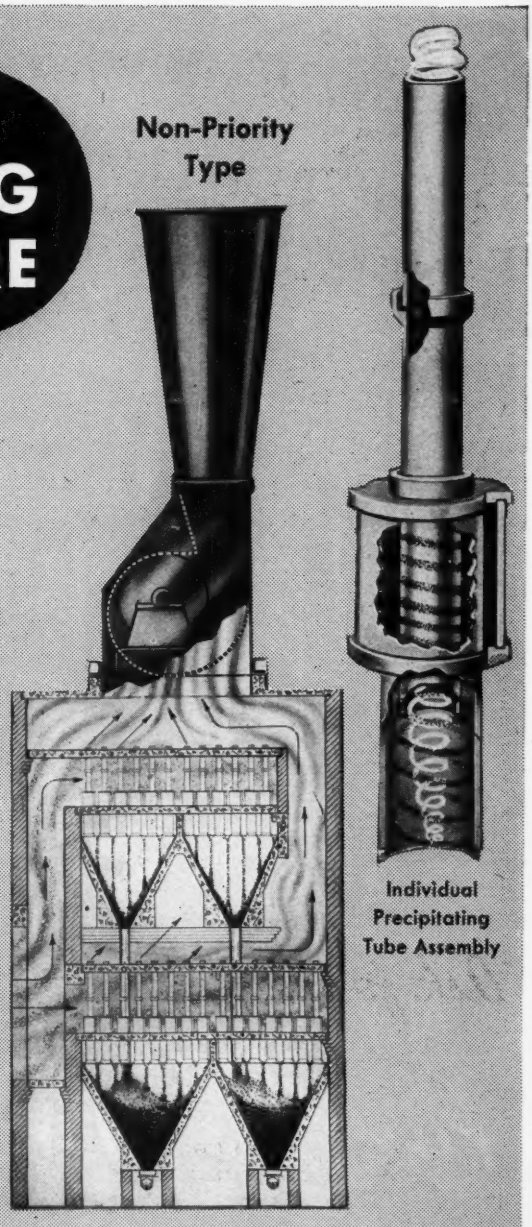
You don't have to wait until after the war to get a Thermix Ceramic Dust Collector. You can install one *now without a priority,* for it is constructed of non-critical materials.

Instead of using steel for the tubes, they are made of fire clay so thick and rugged that they are even harder than steel, yet they weigh no more. Temperature changes and normal handling do not affect them.

In spite of the non-critical materials used, this new Thermix Dust Collector retains all the features which have resulted in the high efficiency of the Thermix Steel Dust Collectors now used for the collection of fine dusts, powders and fly-ash in connection with over 40,000,000 lbs. of steam capacity per hour.

Moreover, these improved ceramic tubes eliminate corrosion. They are not affected by low temperature gases containing sulphur and can handle high temperature gases. If desired, this Dust Collector can be installed outside of the plant without any additional protecting structure.

Write for bulletin and full particulars, or mail the coupon.



PRAT-DANIEL CORPORATION
Port Chester, N. Y.
General Sales Agents
Thermix Engineering Co., Greenwich, Conn.
Representatives in Principal Cities

Thermix Ceramic DUST COLLECTOR

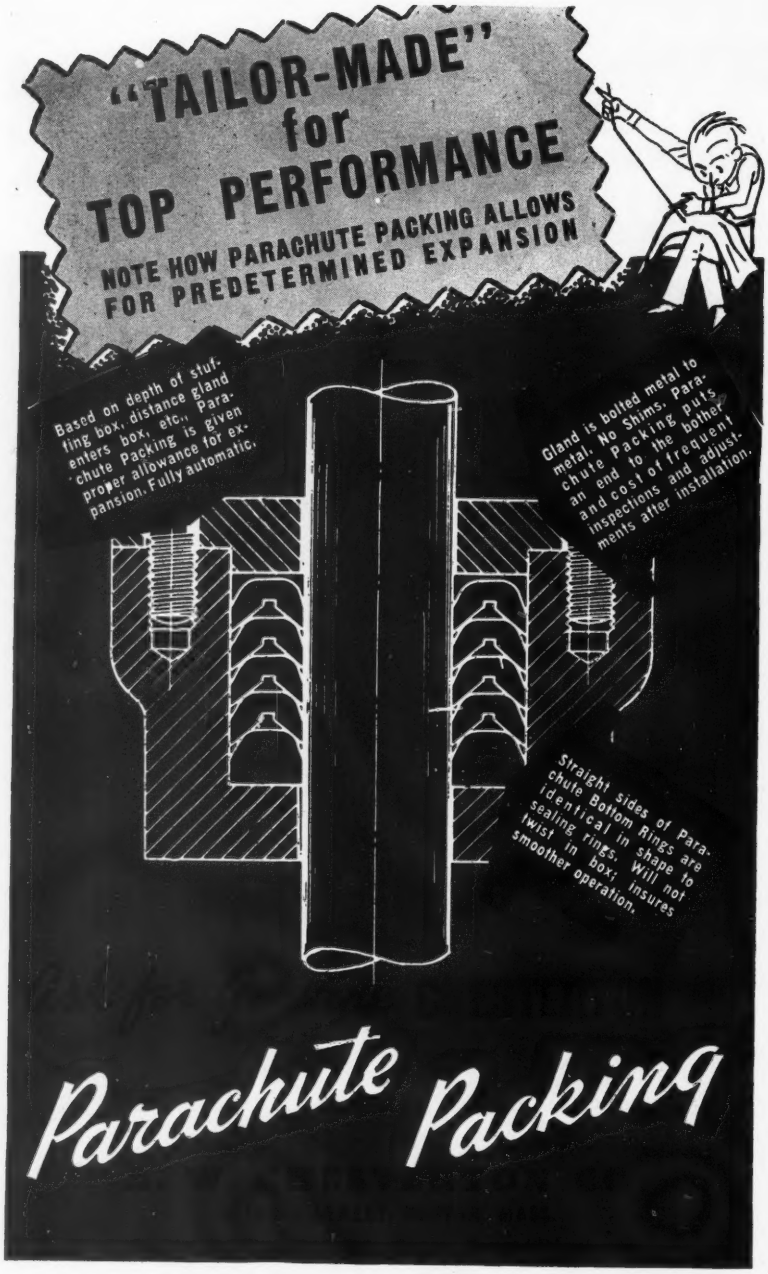
THERMIX ENGINEERING CO.
First Natl. Bank Bldg.,
Greenwich, Conn.

Without obligation on our part, you may send details about the Thermix Ceramic Dust Collector.

NAME .....

ADDRESS .....

CITY ..... STATE.....


"TAILOR-MADE" for TOP PERFORMANCE
NOTE HOW PARACHUTE PACKING ALLOWS FOR PREDETERMINED EXPANSION
Based on depth of stuffing box, distance gland enters box, etc., Parachute Packing is given proper allowance for expansion. Fully automatic.
Gland is bolted metal to metal. No Shims. Parachute Packing puts an end to the bother and cost of frequent inspections and adjustments after installation.
Straight sides of Parachute Bottom Rings are identical in shape to sealing rings. Will not twist in box; insures smoother operation.
Parachute Packing

WHEN YOU WRITE TO ADVERTISERS

When writing advertisers for catalogs, descriptive bulletins or prices, please remember to say, "I saw your message in POWER PLANT ENGINEERING." Thus you'll do a good turn for the advertiser and for this publication. . . .

& Edwards facilities makes possible new standards of quality and value. Products offered in the new Wade line include floor and shower drains, roof drains, grease interceptors, traps and cleanouts and marine specialties, in a complete range of sizes and types. An outstanding member of the line is the Wade Wacor Water Hammer Arrestor, a carefully-engineered, easily-installed device that has proved in hundreds of installations that it brings positive permanent protection against the annoying banging and destructive vibration caused by water hammer.

James Dalton Cunningham, Chicago, Ill., was recently elected to the board of directors of Allis-Chalmers Manufacturing Co., it is announced by Walter Geist, president. Cunningham succeeds Charles W. Cox, New York, a director since 1913, who resigned because of ill health.

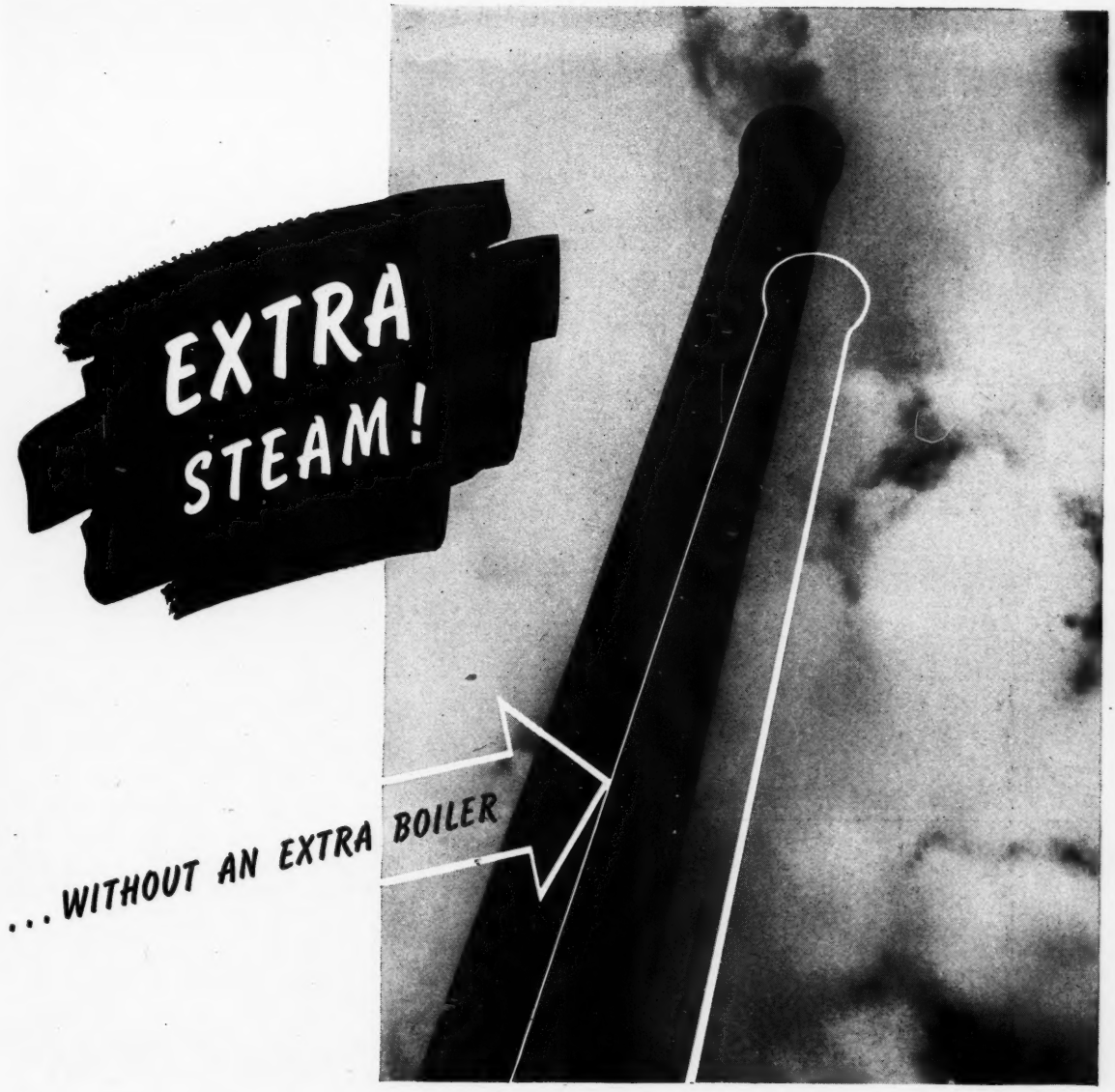
The new Allis-Chalmers director is president of Republic Flow Meters Co., one of the leading companies in the field of power plant instruments and combustion control equipment. In addition, he is president of the Autogas Co., and the Smoot Engineering Co. He is a director of the Lumbermen's Mutual Casualty Co., American Motorists' Insurance Co., the Public Service Company of Northern Illinois, and the National Association of Manufacturers, and a past president of the Illinois Manufacturers Association. He is also chairman of the board of the Illinois Institute of Technology, a member of the Western Society of Engineers, and a fellow of the American Society of Mechanical Engineers.

Staynew Filter Corp. of Rochester, N. Y., will henceforth be known as Dollinger Corp., taking this name from Lewis L. Dollinger, president and founder of the company. This change has come about as the result of recently expanded manufacturing facilities and the development of new products other than filters, making it advisable to change the company name to one of a more general character.

No change whatever in the management, financial organization, or general policies of the company is contemplated at present.

Yeomans Brothers Co. of Chicago has announced the appointment of the Turbine Equipment Co., 75 West Street, New York City, as exclusive representative for all Yeomans products in the New York metropolitan area. Turbine Equipment Co. has sold and serviced pumping equipment from its founding in 1908. Russell Klemm, one of the founders, is president of the company; Harold Sinclair and Donald F. Miller are vice-presidents and Edward Hayes is secretary-treasurer.

Greene, Tweed & Co., New York, N. Y., has purchased the Asbestos Fibre Spinning Co., North Wales, Pa., manufacturer of mechanical packings and mill supply specialties. This consolidation brings together two companies of many years existence; Greene, Tweed & Co. having been established in 1863 and Asbestos Fibre



With the war-time demand for more steam, many owners of Edge Moor Water Tube Boilers have increased the output of their present boiler equipment by installing Edge Moor Water Walls, pre-heaters, economizers, etc. As a result, steam output has been increased as much as 200% and steam costs have been materially reduced!

Edge Moor offers a complete service from design to installation of all steam generating units including: Boilers, Superheaters, Water Walls, Economizers, etc. Call in an Edge Moor engineer today! Have him show you what can be done to boost *your* steam output —and cut *your* costs.

EDGE MOOR
IRON WORKS, INC.
EDGE MOOR, DELAWARE

STEAM GENERATING EQUIPMENT

SALES OFFICES: NEW YORK, N. Y.: 30 ROCKEFELLER PLAZA
CHICAGO, ILL.: ONE NORTH LA SALLE STREET

QUIMBY PUMPS

SCREW
ROTEX
CENTRIFUGAL
CHEMICAL

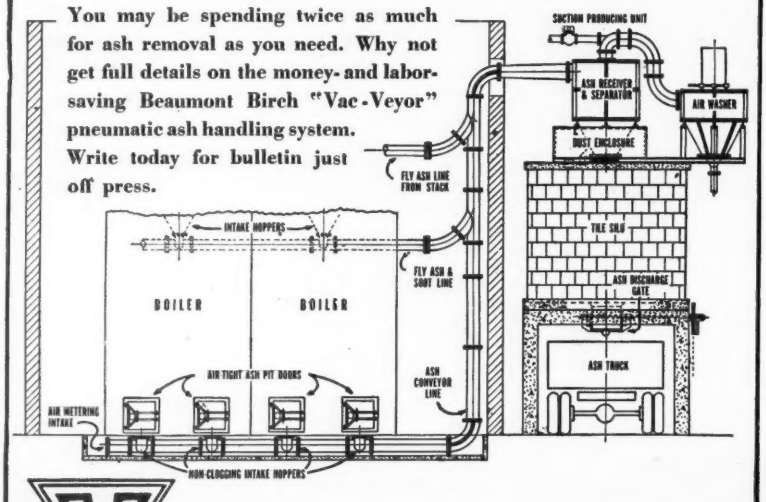
√ LESS FRICTION
√ LESS WEAR
√ LESS MAINTENANCE
IT ALL ADDS UP TO . . .
Longer Life!

QUIMBY VERTICAL SCREW PUMP

QUIMBY PUMP COMPANY
INCORPORATED
Division of H. K. PORTER COMPANY, Inc.
PITTSBURGH, PENNSYLVANIA
FACTORIES:
PITTSBURGH, PA. NEWARK, N.J.
BLAWNOX, PA. NEW BRUNSWICK, N.J.

HOW MUCH ARE YOU PAYING TO HANDLE ASHES?

You may be spending twice as much for ash removal as you need. Why not get full details on the money- and labor-saving Beaumont Birch "Vac-Veyor" pneumatic ash handling system. Write today for bulletin just off press.



BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.

DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

Spinning Co. in 1898. Asbestos Fibre Spinning Co. was established in 1898 by George Shafenacker and Christopher Huber, and throughout its long history has been operated by the same family interests. Greene, Tweed & Co. was one of their customers, having for 25 years purchased their requirements of asbestos yarn from them. No officers have been elected as yet; but O. W. Trumbull, vice president and general manager of Greene, Tweed & Co., will assume the same position with Asbestos Fibre Spinning Co. Plans are now being made to enlarge the facilities and expand the operations of both companies.

To prepare for post-war expansion of air conditioning activities, the Westinghouse Electric & Mfg. Co. has announced the transfer of all heavy duty air conditioning and industrial refrigeration manufacture from its East Springfield, Mass., Works to the Jersey City, N. J., plant of the Westinghouse Electric Elevator Co. An important reason for making this move at this time, according to Mr. Bucher, is to release space for the present vital war work at the East Springfield Works of the Appliance Division. At the same time the accommodation of air conditioning manufacture at the Elevator Company will not interfere with the current war production at that plant. Ross Rathbun has been appointed manager of air conditioning, and Walker G. White succeeds Mr. Rathbun as general sales manager of the Elevator Company.

The General Radio Co. announces the opening of a Chicago district office on December 1, 1943. The office will be managed by Lucius E. Packard of the factory engineering staff and recently in charge of the New York district office, who will be available for consultation on any questions concerning the design, use and procurement of General Radio equipment. The office will be located at 920 South Michigan avenue, Chicago 5, Ill.

NEWS FROM THE FIELD

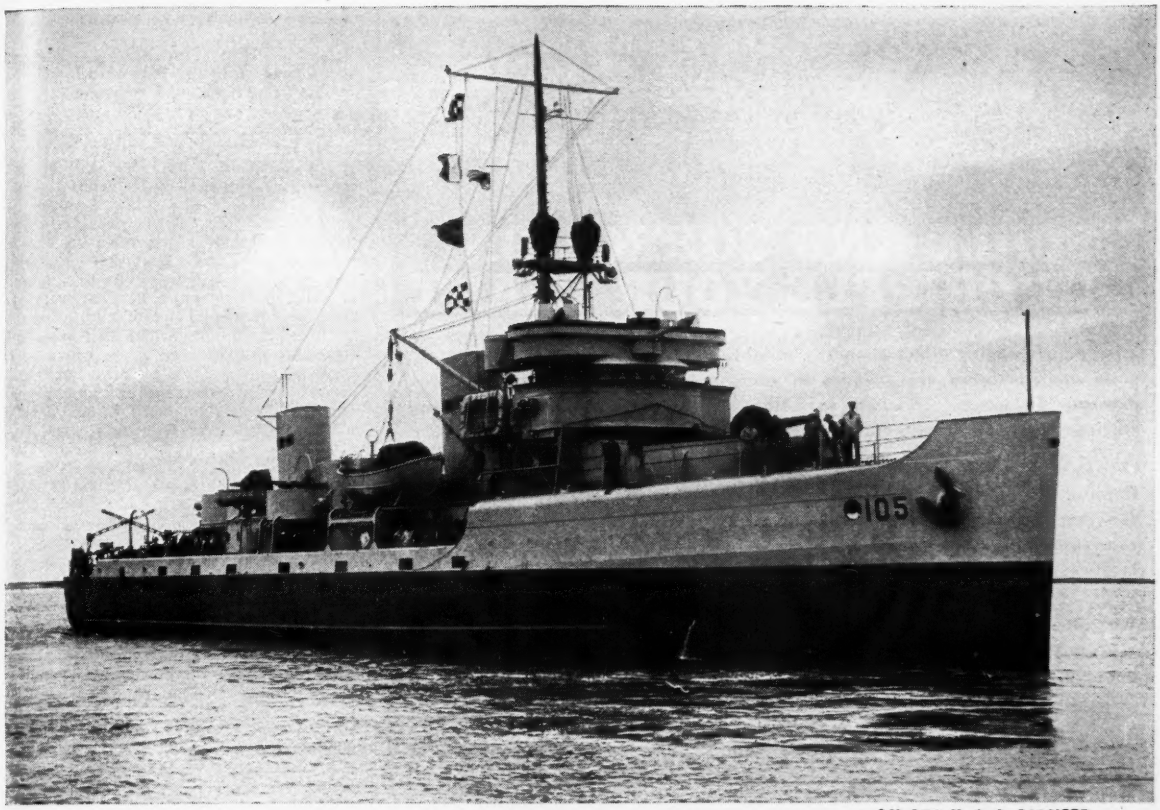
Coal Prospects for 1944

OFFICE OF WAR INFORMATION is the authority for the statement that the United States will enter 1944 with a bituminous coal shortage of approximately 25,000,000 tons. This official forecast by the Solid Fuels Administration assumes that the 1943 requirements exceed an earlier "working estimate" of 600,000,000 tons by 5,000,000 tons and that production is more than 12,000,000 tons a week for December.

The deficit will appear in depleted stockpiles—coal stored in the bins of industrial users and retail dealers—which on October 1 amounted to a 45-day supply. Stockpiles will have been reduced from 86,000,000 tons at the beginning of 1943 to approximately 60,000,000 tons at the beginning of 1944. This will be only a little more than a month's backlog.

From information supplied by the Solid Fuels Administration, the situation may be summarized as follows:

(1) The coal shortage is acute now,



AM-105 U. S. S. PIONEER

She Has Good Stuff in Her

She has to have. The U.S.S. Pioneer is one of our Navy's mine sweepers. Cruising around in quest of enemy mines keeps a sailor on his toes. Naturally, he feels confident when he knows he can rely on his ship. We're proud to say that the U. S. S. Pioneer is propelled by Diesel engines—made by the same Busch-Sulzer skilled workmen who are turning out precise ammunition hoists for the Navy's 5"/38 caliber guns . . . and engines for other naval and army craft, as well as engines for the U. S. Maritime Commission. Until this war program is completed, we can accept orders of high priority only for engines from 450 to 3600 horsepower.

BUSCH-SULZER BROS.—DIESEL ENGINE COMPANY
ST. LOUIS

AMERICA'S OLDEST BUILDER OF DIESEL ENGINES

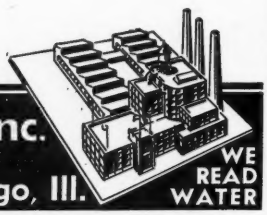
BUSCH-SULZER ST. LOUIS

SCALE AND CORROSION CAN CRIPPLE YOUR PLANT

Your plant is being attacked today, tonight, every day by a destructive force. Scale and corrosion are enemies to your piping system, boilers, and condensers. So secretive is their work that before you realize it your plant efficiency is reduced and your production slowed up.

Call in a Haering engineer today without obligation. He will show you how Haering Glucosates save you money and increase production. He will prove to you that Haering Glucosates correct these conditions definitely and protect your equipment against scale and corrosion.

Write for these booklets:
"Organic Methods of Scale and Corrosion Control"
"H-O-H Lighthouse"



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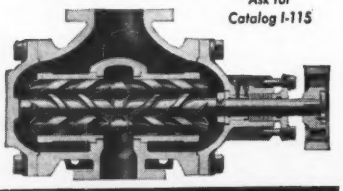
GENERAL OFFICES:
205 West Wacker Drive, Chicago, Ill.
WE READ WATER

IMO *Reliability* IN NAVAL SERVICE

The reliability of IMO "lube" and fuel oil service pumps is typified by their trouble-free performance on a United States Destroyer reported to us by the Navy as having steamed over 84,000 miles on convoy duty during the past year, often cruising as much as 28 days per month without time for normal upkeep and overhaul.

Ask for Catalog I-115



***IMO* PUMP DIVISION**
of the De Laval Steam Turbine Company
Trenton 2, New Jersey

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Radial Brick Chimneys
Common Brick Chimneys
Ornamental Chimneys
Linings for Steel Stacks
Chimney Repairs and Extensions
Installing, Repairing Lightning Rods

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147 Fourth Ave., New York City

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CLEVELAND, O. • DETROIT, MICH.

and most factors point to an increasing deficit next year.

(2) It is not sudden but has been progressive from the first of this year.

(3) It is a delayed shortage, in that it draws on stockpiles. But its effect is immediate to the consumer under the stress and dislocation of distribution.

(4) Demand for 1944 will be increased by shipments to Europe to sustain military operations and to meet essential needs. This will be necessary even though England is scheduled to supply more coal to Europe next year. (American machinery is being sent to England to make possible more English-produced coal for continental operations.)

In a previous report on fuel prospects issued by the Office of War Information June 21, 1943 (OWI-2050), war and civilian requirements of bituminous coal for 1943 were announced as 600,000,000 tons. For anthracite the figure was 65,000,000 tons. These goals meant that the country should produce 20,000,000 more tons bituminous and 5,000,000 tons more anthracite than it had in 1942. The Solid Fuels Administration has found that consumption for the year will be even greater than the hoped-for production goals. This is because the domestic use and exports of bituminous coal for the 12-month period ended September 30 already aggregated about 600,000,000 tons and it is expected that consumption for the remaining three months will be greater than for the same period last year, so that civilian and war needs for the calendar year 1943 will exceed 600,000,000 tons.

Bituminous production in 1943 through November 27 was 529,020,000 tons. The remaining work weeks of the year, allowing for holidays, would have to yield an average of 12,000,000 to make the year's production exceed 580,000,000 tons.

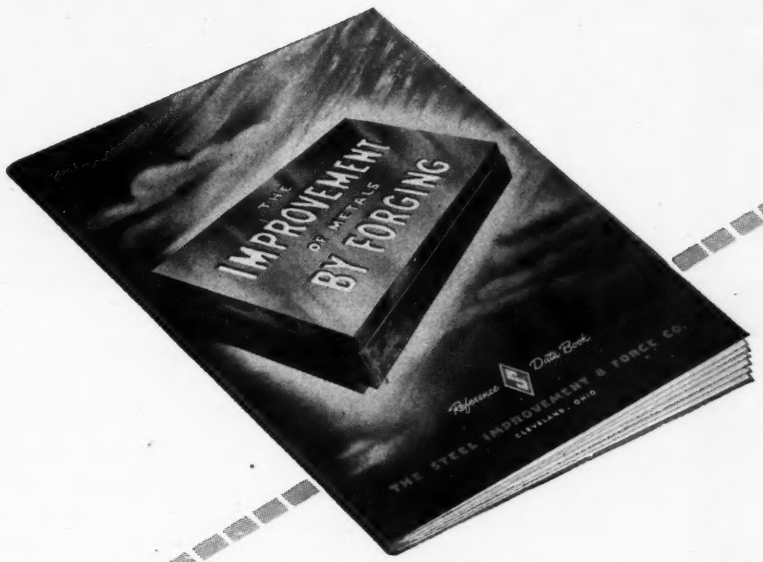
At the rate of coming requirements, coal stocks above ground by March 31, 1944, will represent considerably less than a month's supply for the nation—a dangerously low level. If stocks cannot be replenished in the summer, the situation next fall, when the heavy burning season begins, will approach catastrophe.

Ohio Power Co. to Build New Generating Station

Ohio Power Co., Canton, Ohio, has approved plans for new steam-electric power plant on Ohio River, vicinity of Steubenville, Ohio, and will proceed with construction at early date. No official estimate of cost has been announced but reported in excess of $3,000,000, with turbine-generator units and accessories, high-pressure boilers and auxiliary equipment. Project will include extensions in transmission lines for connection with high-tension system in that area, with switching station and other operating facilities. Contract for station erection has been awarded to Sollitt Construction Co., South Bend, Ind. Company also has concluded arrangements for purchase of tract of about 6000 acres of coal lands in same vicinity, and will develop for fuel supply for new station. A complete coal-mining plant will be installed, with electric-operated machinery. Project will include waterfront construction, with dock facilities, ice breakers and other structures. It is understood that priority ratings have been secured for entire development, which will require more than 12 months for completion. Company is a unit of American Gas & Electric Co., New York, N. Y.

One purpose...

the IMPROVEMENT of Metals



Photographic reproduction of 40 page Technical Reference Data Book

by Forging

Practical suggestions on the use of forgings for product improvement, post-victory, as well as for war equipment, may be obtained from this new Technical Reference Data Book which has been specially prepared for Design Engineers, Metallurgists and Production and Management Executives. The technical information it contains on THE IMPROVEMENT OF METALS BY FORGING, provides dependable guidance for those who desire to utilize the advantages of forgings in the most practical way. All phases from Forging Design to Forging Metallurgy are treated. Write for a copy on your business letterhead.

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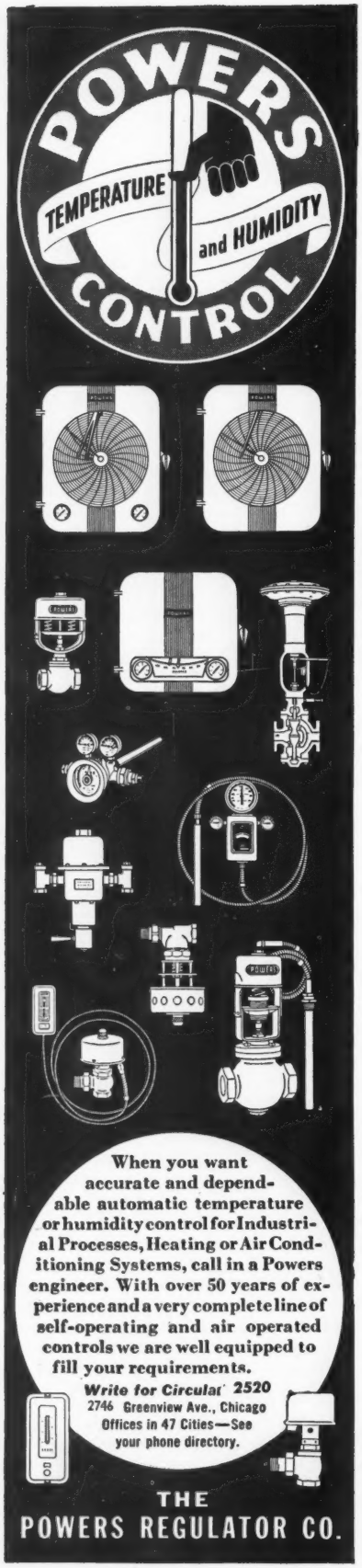
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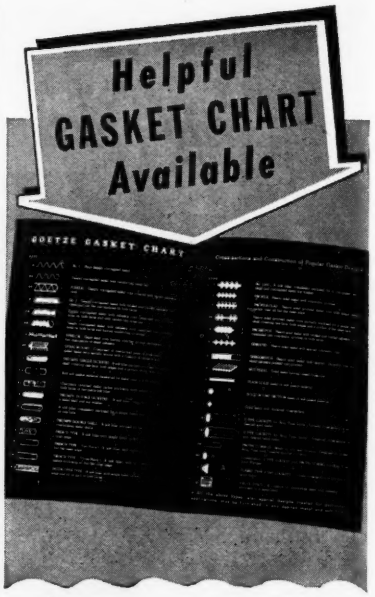
California Municipalities Plan Postwar Power Expansion

A NUMBER OF CITIES in Southern California have plans under way for post-war expansion and improvements in municipal power plants, as well as other utilities, with programs largely privately financed and ready to proceed as soon as restrictions are removed on building materials and required machinery and equipment.

At Pasadena, the Municipal Light and Power Department proposes to build a new addition to municipal steam-electric generating station, to include installation of a 45,000-kw turbine-generator unit and auxiliary equipment, boilers and accessories. Cost is estimated at $3,000,000. Work will include a new power substation, extensions in transmission and distributing lines, service connections and other operating facilities for increased power supply throughout the city. The latter program will involve an estimated cost of $2,000,000, making a gross expenditure of $5,000,000. Of this amount a reserve fund of $3,000,000 is now available, and remainder of fund will be provided through earnings of department, of which Benjamin F. DeLanty is general manager.

Public Service Department, Glendale, has plans for new addition to municipal steam-electric power plant on San Fernando Road, with installation of a 20,000-kw turbine-generator and auxiliary apparatus, boiler unit and accessories. Project is estimated to cost approximately $1,200,000. Other work now planned by Department includes extensions in underground transmission lines to cost about $700,000; and additions to overhead system in different parts of municipality, with replacements in present lines, crossarms, etc., to cost close to $660,000; a new power substation unit in Tropico district, estimated at $75,000; a new public service warehouse on Howard St., to cost about $250,000, with equipment; and a new public service garage, estimated at $41,000. It is also proposed to install new motor-driven booster pumping units at main pumping station for waterworks system on San Fernando Road; with new aerator settling basins, a fund of about $180,000 is being arranged for this work. Peter Diederich is superintendent of department.

The City of Long Beach, which secures service from Southern California Edison Co., is arranging for extensive postwar expansion in street-lighting system, including both ornamental standards and suspended luminaries on a number of thoroughfares, with gross expenditure estimated at $840,000. The Gas Department of the city will carry out additions and improvements in plants and system to involve an estimated cost of approximately $4,300,000. About $2,000,000 of this amount is being allotted for installation of 200 miles of 3 to 6-in. steel pipe lines in different parts of the city, and about the same amount of 1¼-in. steel service pipe, with over 20,000 gas meters, regulators and auxiliary facilities. A new natural gas storage plant is planned in vicinity of Santa Fe Ave. and 233rd St., consisting of series of eight horizontal pressure tanks, with total capacity of 4,000,000 cu ft, including compressor station and auxiliary equipment, estimated to cost $735,000; a low-pressure gas storage plant will be built in Belmont Shore district, with a



An up-to-the-minute Gasket Chart showing the cross-sections of 36 most popular Gasket Types, their purposes and the characteristics which fit them for the specific services intended, is now available to interested engineers.

This chart has been issued as the third in a series of technical papers on Gaskets compiled by the Research Laboratory of the Goetze Gasket and Packing Company, Inc., oldest and largest manufacturers of industrial gaskets in America.

In requesting copies of this and succeeding issues of "The Gasket," write the company on your business letterhead, mentioning your position.

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Today, when every minute of production time gained brings Victory that much closer, the Westinghouse TWO-FOLD Switchgear Service puts application on a wartime basis. It insures getting the *right* switchgear in the *minimum* time with the *least* expenditure of Critical Material.

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will save 30% of the time usually required to order, build, and install switchgear. Nowhere else can you find so much factual, easy-to-use switchgear information.

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PLANTS IN 25 CITIES... OFFICES EVERYWHERE

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OAKITE CLEANING

. . . Improving Heat Transfer of Your Feed Water Heaters

Unless lime-scale and other deposits that accumulate in feed water heaters are removed, heat transfer is reduced and operating efficiency impaired. When this occurs, the best thing to do is to get rid of these insulating accumulations QUICKLY.

Do this job easily, thoroughly by using OAKITE COMPOUND No. 32! Just circulate recommended solution for required period as directed by our nearby Technical Service Representative. You will find deposits are effectively, safely removed . . . normal operating efficiency restored!

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Specialized cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

steel gas storage holder of 5,000,000 cu ft capacity, estimated at $800,000, with compressor units and accessory apparatus; at No. 4 gas plant on Spring St., a new fuel oil storage program will be carried out, consisting of a battery of 12 high-pressure tanks, with gross capacity of 500,000 gal, with total cost approximating $350,000; a new natural gas transmission and feeder system will be installed, consisting of about 16 miles of 16, 12 and 10-in. welded steel pipe, estimated to cost about $350,000. George E. Baker is city engineer.

New Gas Pipe Line in Ohio to Cost $2,800,000

THE EAST OHIO GAS CO., 1405 East Sixth St., Cleveland, Ohio, has plans maturing for construction and operation of new 20-in. welded steel pipe line for natural gas transmission in state. New line will run from Maumee, Lucas County, to a point in Summit County, between Cleveland and Akron, a total distance of 120 miles. At first noted place, connection will be made with natural gas system of Panhandle Eastern Pipe Line Co., which will furnish supply to East Ohio company from gas fields in Texas, Kansas and Oklahoma. From this point transmission will be carried out by last noted company to its Brush Farm valve station and distribution plant in Summit County mentioned. Entire project is estimated to cost about $2,868,000, with compressor stations at points along route, and other operating facilities. Company has secured permission from Federal Power Commission to carry out project and work will begin at early date. All financing will be provided by company funds.

Utility Output Increases 75 Per Cent in 4 Yr

THAT 1943 has been a proud and successful year for the electric utility industry, for the important contribution it has been able to make toward winning the war, is the conclusion of C. W. Kellogg, president, Edison Electric Institute, in his year-end statement issued December 20. From the construction of each factory and camp to the arming and equipping of every soldier and sailor, electric power has played its indispensable part in the production of planes, tanks, guns, ships, transport, ammunition, food and other supplies. It has been the duty and privilege of the electric utilities to supply the vital energy every second of every hour of every day of the year. No war program has been delayed by lack of generating capacity and at the same time full service has been maintained to the civilian population.

In the four years since September 1939, when the Germans invaded Poland, the total output of electricity by public utility plants has grown from 126 billion kwhr per year to 221 billion, or by 75 per cent, while generating plant has increased from 40,000,000 kw to a present figure of 50,000,000 kw or by 25 per cent.

The 1943 increase in output was 32 billion kwhr or 17 per cent, over the production in 1942. This compares with a gain of 20,700,000,000 kwhr, or 12 per cent in 1942 over 1941 and with 23,185,000,000, or 16 per cent in 1941 over 1940.

Installed capacity in the public utility power houses increased during 1943 by more than 3,000,000 kw bringing the total at the present time to approximately 50,000,000. During the past five years, generating capacity has grown by some

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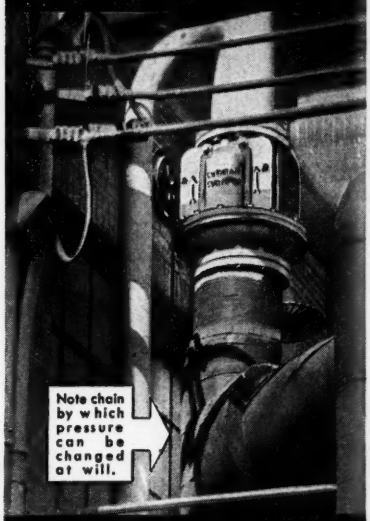

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EASILY and QUICKLY

1 Multiple valve disks, instead of one large disk.
2 Individual lifting spindles and hold-down springs.
3 Pressure Plate by which predetermined pressure is adjusted.
4 Adjusting hand wheel. This can be operated by hand, chain or motor.

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MULTIPORT
RELIEF VALVE

fireye Prevents Explosions

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GUARDS AGAINST FLAME FAILURE PHOTOELECTRICALLY

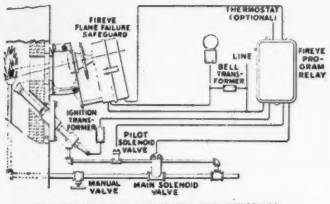
Monitors oil, gas, pulverized coal burners *electronically*. Instantly detects flame failure, cuts off fuel supply.

Controls Every Flame—positively observes even blue transparent gas pilot flame—is the *only* photoelectric safeguard sufficiently sensitive for use with all fuels and for monitoring pilot, main flame, or both.

Acts Instantly, Dependably—is the only control that detects flame failure entirely by direct observation of the flame itself. All other control methods rely wholly or partly on temperature, electrical conductivity or other indirect and, therefore, less positive flame characteristics.

Provides Completely Automatic Control—is used alone for control of manually ignited burners, to turn off both main and pilot valves and sound an alarm; or, when burner is automatically fired with Program Relay Type R25, to provide desired sequence of fuel pump and valve operation.

For complete information, write today for Catalog 50



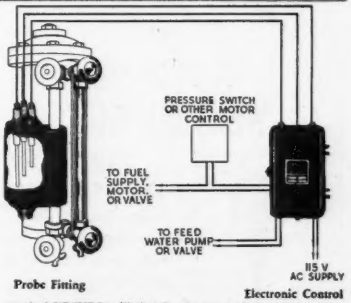
TYPICAL FIREYE INSTALLATION FOR AUTOMATICALLY IGNITED OIL BURNER

fireye BOILER FEEDWATER CONTROL

Floatless . . . Maintenance-Free . . . Electronic

- Maintains Desired Water Level Automatically.
- Instantly Cuts Off Fuel Supply and Sounds Alarm at Low-Water Danger Point.
- Fireye Boiler Feedwater Control operates electronically, contains no moving parts to wear out or fail in operation, is simple to install—at last makes available to the average power plant completely automatic control—at low cost.

Write today for Catalog 51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TO FUEL SUPPLY, MOTOR, OR VALVE
TO FEED WATER PUMP OR VALVE
115 V AC SUPPLY
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ENGINE *ALARM* SYSTEMS

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CONTACT MAKERS

Pressurestatic or Thermostatic Contact Makers for lubricating-oil or circulating-water systems for all types of stationary or mobile equipment.

Now available in sheet-steel housing to avoid critical materials.

Can be supplied with complete indicating system.

COMPLETE ALARM SYSTEM

TYPE M-3B

Complete alarm system consists of Type M-3B combination pressure control, junction box and visual indicator, together with Type M Thermostatic Contact Maker, and signal howler.

WATER- AND WEATHER-TIGHT

TYPE C

CONTACT MAKERS

Where Contact Maker is exposed or must be waterproof, Type C Pressurestatic or Thermostatic is recommended.

Manufacturers of engine alarm systems, annunciators, marine and industrial instruments. Write for specifications.

VIKING INSTRUMENTS, INC.

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11,000,000 kw, which increase alone is greater than the entire capacity of all the country's power houses at the beginning of the last war.

Edison Medal Awarded to Vannevar Bush

VANNEVAR BUSH, president of the Carnegie Institution of Washington and Director of the Office of Scientific Research and Development of the Office of Emergency Management, Washington, D. C., has been awarded the 1943 Edison Medal of the American Institute of Electrical Engineers.

The award goes to Doctor Bush "for his contribution to the advancement of electrical engineering, particularly through the development of new applications of mathematics to engineering problems, and for his eminent service to the Nation in guiding the war research program." The medal will be presented on January 26 in a general session of the winter technical meeting of the Institute, in the Engineering Societies Building, New York City.

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee of the American Institute of Electrical Engineers.

Doctor Bush has been chairman of the committee on new weapons and equipment of the joint U. S. chiefs of staff since 1942, and is a member and former chairman of the National Advisory Committee for Aeronautics. He was formerly a member of the Business Advisory Council of the Department of Commerce.

Exposition Previews the Chemical Future

SPECTACULAR post-war advances in industrial chemistry were forecast at the 19th Exposition of Chemical Industries, held in Madison Square Garden, New York, December 6-11, inclusive. Exhibitors of industrial chemicals, processing materials and production equipment, most of whom are now engaged in war work, were revealed at the Exposition to be laying definite plans for the future; making all possible allowances for the many indeterminate elements in the outlook, but definitely getting ready to "go" when the time comes.

Synthetic materials, from the rubber group through to the harder substances, some of which are now used for structural purposes, edging toward the fields of metals and ceramics, among others, naturally engaged a good deal of the visitors' attention.

The American Chemical Society's exhibit of recent achievements featured models of cracking operations of two different types, used in the manufacture of aviation gasoline and synthetic rubber.

Also on view at the A. C. S. exhibit was a display of the brand new method of "heatronic" molding of plastics, in which the molding material is electrostatically preheated. Uniform preheating throughout the material, brought about by using a high-frequency electric field, has reduced molding time from minutes to seconds, permitted much lower molding pressures, produced moldings of greater uniformity, makes possible a universal molding method and has so far reduced

(*Continued on page* 178)

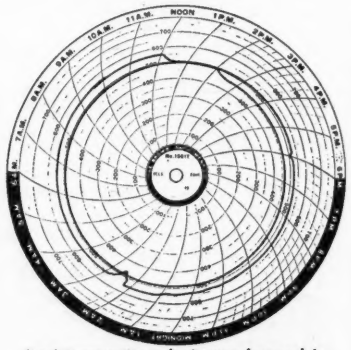
XZIT

SOOT AND FIRE-SCALE ERADICATOR

Reduces Stack Temperature Increases Boiler Efficiency

STACK temperature readings provide one measure of boiler efficiency. Flue temperature charts made before and after using XZIT definitely prove its effectiveness. In practically every case where XZIT has been used to remove soot and fire-scale, a substantial increase in operating efficiency has resulted.

XZIT is fed into the fire-box, and does its work while the boiler continues operating. Continued use of XZIT keeps heating surfaces clean for maximum heat transfer. Write for full information.



Stack temperature charts superimposed to show improvement in operating efficiency produced with XZIT. Before XZIT-temperatures—500 to 550 deg. Tubes blown every 12 hours. After two weeks with XZIT-temperature—450 to 500 deg. Tubes blown once daily.

XZIT SALES CO.

1031 Clinton St., Hoboken, N. J.

HELPFUL BULLETINS

Practical answers to many wartime problems of plant operation and maintenance are found in the engineering bulletins offered by manufacturers. For your convenience we publish the following summary of helpful literature available. To obtain copies of the bulletins and catalogs described, simply indicate the paragraph numbers on coupon on next page, detach and mail.

BOILER PLANT EQUIPMENT

1 **Conversion to Coal**—New Link-Belt Conversion Book No. 1970 describes commercial and industrial stokers in a full range of sizes up to 300 bhp available for conversion from oil or gas to coal. Link-Belt Co.

2 **Variable Capacity Oil Burners** — Catalog, 22 pg, describes a new type of mechanical pressure atomizing fuel oil burner adjustable over various firing rates without changing burner tips or oil supply pressure—illustrated, with useful engineering charts. Todd Combustion Equipment, Inc.

3 **Heat Enclosure For Bent Tube Boilers**—Reintjes Bulletin No. 431, describes a simple sectionally-supported wall for the upper side wall areas of bent-tube boilers. This construction, is said to eliminate the objectionable features inherent in the conventional solid masonry often used for the side wall areas above the drum supporting girders. It permits freedom of expansion of the drums while maintaining a tight air seal around the drum ends. George P. Reintjes Co.

4 **Compact Steam Generator** — The Union "H" generator which provides large steaming capacity in small space, is described in Bulletin 27. Each side furnace wall is a steam generator in itself, yet an integral part of the boiler unit. Union Iron Works.

5 **Spreader Stokers**—Bulletin No. 78 describes the Fyr-Feeder multiple spreader type stoker under the theme "burns coal like oil." The principle of the multiple spreader stoker is included with detailed illustrations and installations. American Coal Burner Co.

6 **Oil Burning Handbook** — A new vest-pocket size combination memo and reference booklet is being distributed to the oil-burning trade by Preferred Utilities Manufacturing Corp. Half of the 190 pg are for notes and sketches. The other half contains a wealth of engineering data on heating, steam power and the more commonly employed electrical formulae. Included also are a number of conversion factors and miscellaneous information such as engineers find useful from time to time.

7 **Unit Type Stoker**—Bulletin No. 600 tells about savings of Detroit Uni-Stokers in various industrial plants. These single retort, plunger feed, unit type stokers are flexible in operation, burn all grades of coal, serve boilers 125 to 300 hp. Detroit Stoker Co.

ELECTRICAL EQUIPMENT

8 **Insulation Tester**—The new U.S.-made "Megger" insulation tester, in plastic molded case, and said to have the same ruggedness and accuracy common to all "Megger" instruments, is described in new Bulletin 1735-PE. James G. Biddle Co.

9 **Making Motors Last**—"Hints to Make Motors Last" is the title of handy little booklet for engineers and maintenance men. Check chart tells what to do when motor fails to start, runs hot, is noisy, shows excessive brush wear, etc. Westinghouse Electric & Mfg. Co.

10 **Load Center Unit Substations** — "Packaging Pays Off" is the title of a new Allis-Chalmers bulletin describing standardized load center unit substations of 100 to 2000 kva capacity for meeting the power supply needs of all types of industries. Feature of the bulletin is an alignment chart, which makes it possible to select the correct air circuit breaker for any application of a standardized load center unit substation. Advantages of the new load center power distribution system are quicker delivery of equipment, easier installation, critical material saving, and lower initial cost.

11 **Electrical Control for Resistance Welding**—Attractive 46-pg booklet (GET-1170) contains published articles by General Electrical engineers on the circuits and operation of electronic controls for resistance welding. Simplified circuit diagrams are used liberally in explaining the fundamentals of the many types of G-E electronic controls available. Titles of the six articles reproduced in the booklet are: Electronic Welding Control; Seam and Pulsation Welding Controls; Special Welding Controls; Timers for Welding Control; Energy Storage Welding Controls; and Servicing Resistance Welding Controls.

FANS, PUMPS AND COMPRESSORS

12 **Pumps and Hydraulic Equipment**—16-pg illustrated catalog covers representative pumps and hydraulic equipment for power plants, oil fields, process industries and marine use. Text is descriptive of the many types of pumps shown and lists their applications—issued by The Aldrich Pump Co.

13 **Steam Turbine Pump**—New Bulletin describes the Coffin steam turbine centrifugal pump. This modern boiler feed pump has a centrifugal pump and steam turbine mounted on a common shaft to end alignment difficulties, save space and weight. Available for capacities up to 500 gpm and pressures up to 750 psi. J. S. Coffin Jr. Co.

14 **Handbook On Centrifugal Pumps**—Allis-Chalmers' new pump maintenance handbook gives a grand "refresher" course in alignment problems, figuring head, preventing cavitation, etc. Applies to all makes of pumps. Allis-Chalmers Mfg. Co.

15 **Pump Engineering Data**—How the single Westco turbine pump gives multi-stage performance, plus installation layouts and many pages of conversion tables and other timesaving pump engineering data are included in the new Westco Catalog just off the press. Joshua Hendy Iron Works, Pomona Pump Co. Div.

INSTRUMENTS AND CONTROLS

16 **Motor Control Renewal Parts**—The job of ordering motor control parts is simplified by the new free Cutler-Hammer Renewal Parts Guide. Also includes many practical maintenance ideas for prolonging the life of controllers, resistors, magnets, brakes and clutches. Cutler-Hammer, Inc.

17 **Pyrometer Accessory Manual**—The Bristol Co. has recently published a new Pyrometer Accessory Manual, No. P1211, giving helpful engineering data on the selection and installation of thermocouples, protection wells, and lead wire; thermocouple and protection well assemblies; and calibration data and tables. Other information such as molten metal thermocouples, radiation couples, surface contact couples and special fittings is also included.

18 **Feed Water Regulator** — Bulletin 435 summarizes the performance record of Copes Flowmatic, the steam-flow water-level feed water regulator. Folder reviews the wide acceptance of the Flowmatic throughout many industries on various types and sizes of boilers, and the results obtained by users. Northern Equipment Co.

19 **Automatic Controls** — Catalog 600 describes the Mercoid line of automatic controls for regulating electrically operated equipment in accordance with changes in temperature, pressure, vacuum, fluid level or mechanical movement. Mercoid Corp.

20 **Potentiotrols** — New Bulletin A2-3 covers Wheelco line of potentiotrols. Describes the poteniometer method of heat measurement, and explains the electronic principle employed in the company's instruments to gain instant control in line with the temperatures recorded. Also included is a list of instrument features, four operating diagrams, and a table of potential scale ranges obtainable with various thermocouples and a photoelectric pickup unit. Wheelco Instrument Co.

21 **Micromax pH Recorders**—With pH at correct value, it is claimed, corrosion can be reduced and in place of a sticky sludge, there is a simple deposit, easily removable with boiler blowdown water. Of timely interest, therefore, is a general catalog just issued by Leeds & Northrup Co. describing an equipment which continuously and automatically measures pH. Equipment consists of two elements: an unusually rugged glass electrode assembly and a Micromax indicating recorder. A continuous sample of water flows through the electrode assembly chamber.

22 **Cooling Controls** — Twelve pg bulletin No. 700 on Sarco cooling controls, covers self-operated temperature regulators and mixing valves, to control cooling circuits on internal combustion engines, compressors, condensers, degreasers, stills, etc. Completely illustrated, including many typical hook-ups, also capacity tables, prices, etc. Sarco Co., Inc.

List Items You Want On Handy Coupon On Following Page

23 **Steam Flow Meter**—Bulletin 318-A explains how the Builders Flowatch meter records, indicates and totalizes the flow of steam. Recommended for steam control purposes where an hour by hour chart record of production or consumption is desired. Builders-Providence, Inc.

24 **New Boiler Meter**—Bulletin No. 420 tells how the new Republic boiler meter provides in one instrument all the essential information concerning boiler performance at any time. One chart covers steam flow, air flow, flue gas temperature or steam pressure. Republic Flow Meters Co.

MECHANICAL TRANSMISSION

25 **Belt Drive Handbook**—New 70-pg Handbook explains the unique automatic belt tension control feature of American Econ-o-matic drives. It shows how and why Econ-o-matic drives increase machine production through eliminating belt slip, increase belt and bearing life and reduce drive maintenance. In addition, the handbook gives you complete V-belt and Flat-belt drive selection tables, specifications and installation instructions. The American Pulley Co.

26 **Gears**—Combination catalog and gear data book, 72 pg includes dimension tables for various gear types, as well as data on speed reducing units, motoreducers, and electric hoists. Also contains practical engineering data section. Philadelphia Gear Works.

27 **Bearing Metals** — 8-pg bulletin gives many helpful hints on how to keep bearings on the job and shows what bearing metal to use for every application. Magnolia Metal Co.

28 **Handling Of Elevator Rope**—Bulletin No. 43-73 gives timely information on proper handling of elevator rope in installation and care afterwards. Also includes data on diameters, weights, grades, strengths of Macwhyte elevator ropes. A valuable reference book for engineers and maintenance men. Macwhyte Co.

PIPING, VALVES AND FITTINGS

29 **Steam Pipe Insulation**—For complete table of sizes, list prices, etc. on this equipment, send for bulletin "They'll Specify Unibestos . . ." Half-section construction for all pipe sizes up to 36 in., thicknesses up to 5 in. Easily applied—saws or cuts clean and sharp with ordinary tools. Provides plants with higher thermal efficiency. Union Asbestos & Rubber Co.

30 **Welding Pittings and Flanges**—For stronger, lighter, permanently leakproof piping systems, many plants use Tube-Turn fittings. No torch cutting or fitting fabrication needed. Helpful catalog and data book No. 111 contains 232 pg of technical studies and engineering data. Tube Turns, Inc.

31 **Industrial Steam Traps** — Bulletin No. 843 describes the Nicholson line of traps, available in five types—sizes ¼ in. to 2 in.—pressures to 225 lbs. Many exclusive, important features make these traps ideal for draining condensate from all types of steam heating and processing units. W. H. Nicholson & Co.

32 **Tilting-Disc Check Valves**—Exclusive Chapman design cuts head loss 65% to 80%. Airfoil design of disc offers minimum flow resistance — streamlined body contains no obstructions. Disc can't slam—no vibrations, surging, hammering or opening of pipe joints. Write for Bulletin No. 30. Chapman Valve Mfg. Co.

33 **Purification of Steam, Gas, Air**—Bulletin No. 1929 describes "fine separation" of liquids from steam, gas, and air with Tracyfiers. This method removes the small droplets; reduces superheater, turbine and engine maintenance; helps recover valuable industrial liquids. Blaw-Knox Div. of Blaw-Knox Co.

34 **Steam, Air and Water Equipment**—Condensed bulletin 232-1140 describes a line of rotary pressure feed pumps, automatic boiler water controls, steam separators, and the Johnson Electrap for boiler feed or lift service. The Johnson Corp.

35 **Expansion Joint Bulletin**—Revised Bulletin EJ-1909 pictures construction features and advantages of Yarway gun-pakt and gland-pakt expansion joints. Also contain helpful data on how to figure expansion of pipe lines, how to figure anchors, etc. Yarnall-Waring Co.

36 **Steam Trap Handbook** — Tables, charts, diagrams and rules for selecting traps, giving complete explanations, make the new 36-pg Armstrong Steam Trap Book a handy reference volume for every engineer's library. Armstrong Machine Works.

36-A **High Pressure Butterfly Valves** —36-pg Catalog No. 14-B describes a complete line of butterfly valves, both manual and power operated, for pressures from 15 to 900 psi. Contains detailed specifications, applications and descriptions. Among illustrated valves is a dual type, designed for a high pressure drop and small volume or a low pressure drop and large volume. R-S Products Corp.

PRIME MOVERS

37 **Diesel Engines**—12-pg Bulletin No. S-500-B36B covers type CC Diesel engines with specifications, auxiliaries, application data, cooling equipment, principal dimensions, and ratings. Also includes photographs and cross-sectional diagrams. Worthington Pump and Machinery Corp.

38 **Turbines**—Bulletin 1359 describes Coppus steam turbines, precision-made, controlled by Johnasson size blocks. Comes in 6 frame sizes; matching size to job. Coppus Engineering Corp.

39 **Vacuum Cooling Equipment** — Steam jet vacuum cooling equipment is the subject of a new brochure, Bulletin G-8, recently published by Elliott Co. The advantages of cooling by vacuum are detailed and illustrated by photographs and flow diagrams. A chart shows the relationship between temperature pressure and volume of water vapor within the normal temperature range for vacuum cooling. The bulletin defines the 12 items of information required when requesting information on vacuum cooling units.

WATER TREATMENT

40 **Control of Boiler Blowdown**—Bulletin 21B gives methods for the control of boiler water concentration to produce the best quality of steam. The advantages of continuous blowdown and a suitable control valve are also shown. National Aluminate Corp.

41 **Chemical Treatment of Boiler Water**—That is the title of Betz Technical Paper No. 84 which presents a helpful discussion of the causes of boiler scale, corrosion, carryover and embrittlement. Also deals with the applications and limitations of commercial chemicals employed for the correction of these difficulties. W. H. and L. D. Betz.

42 **Hot Process Water Softeners**—For complete protection against scale and corrosion; removal of hardness, suspended solids and silica, and corrosive gases, write for 24-page Bulletin 314 which completely describes Hot Process Water Softeners. Graver Tank & Mfg. Co., Inc.

43 **Scale and Corrosion Control** — A series of booklets gives complete data on scale and corrosion control, cooling waters, proportioning problems, etc. Write for sample containers and data forms to give the complete picture of your problems. D. W. Haering & Co., Inc.

MISCELLANEOUS

44 **Tips On Operation and Maintenance** —"Allis-Chalmers Operation and Maintenance Review" is a new pocket-sized magazine succeeding Allis-Chalmers' "Victory Production and Maintenance News." Illustrated with eye-catching color cartoons, the publication aims to broaden interest in problems of wartime maintenance. It contains maintenance tips from Allis-Chalmers engineers, as well as timely articles on current trends for the shopman and the executive. It also invites an exchange of ideas on operation and maintenance from equipment users.

45 **Fire Extinguisher**—Described in recent bulletin is the Randolph "4" carbon dioxide fire extinguisher for quickly freezing and smothering fires around electric motors, switchboards, engine rooms, etc. Rigid horn permit accurate aiming, quick control. Randolph Laboratories, Inc.

46 **Packing Guide**—A helpful guide for the selection of packing is contained in a bulletin published by Greene, Tweed & Co. This bulletin tabulates in alphabetical arrangement more than three dozen different fluids handled in process work and general plant services and lists the correct packing for each liquid, gas and vapor. An additional tabulation describes the form and construction of each G-T packing and lists typical kinds of equipment for which each one is suited. Tables of sizes and weights are also included.

47 **Cooling Towers**—Bulletin 603 describes induced draft cooling towers of so-called conventional or standard type, originally introduced by Marley and widely accepted as practical and progressive equipment. Includes designs, applications, accessories, engineering data.—The Marley Co., Inc.

This coupon must be filled in completely in order to secure the literature you request. Please indicate only the bulletins you particularly desire. Pasting coupon on penny postcard saves you time and money.

JANUARY, 1944

POWER PLANT ENGINEERING

53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph numbers:

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Your Company Name .....

Company Address .....

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48 Scaling Manual — Newly-revised edition of the 28-page Oakite De-Scaling Manual describes procedures now used to restore normal heat transfer efficiency by thorough removal of lime-scale and rust deposits from such equipment as gasoline and Diesel engine cooling systems, lube oil and jacket water coolers, refrigerant condensers and compressors, surface condensers, evaporative condensers and many other types of heat exchange units. Data is also given on an acid-type, scale-dissolving material which eliminates the hazards to personnel and equipment so frequently involved in the use of commercial raw acids for those de-scaling operations. Oakite Products, Inc.

49 Refrigeration's Wartime Jobs — How the science of controlling temperature and humidity has become a powerful wartime tool is told in a handsomely illustrated 36-pg book "Refrigeration and Air Conditioning in War, in Peace." Contains a chart of applications. Air Conditioning and Refrigerating Machinery Assoc.

50 Floors Repaired While Traffic Rolls —Folder "Floor Patch" describes a product that repairs floors immediately and allows you to open the spot to regular traffic immediately. Floor patch is solid and permanent. This new plastic bonds tight to old concrete and withstands extreme loads. Flexrock Co.

51 Packings—A comprehensive line of packings, gaskets, gasket and lubricating pastes, oil seals, etc., is described in a 64-pg illustrated Catalog. Text and tables of recommendation facilitate selection of satisfactory packing material for any packing job. The Garlock Packing Co.

52 Free Repair Handbook and Protractor-Ruler—Company offers free protractor-rule and 40-pg guide for the use of Smooth-On cements, containing 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

53 Welding Chart—A graphic chart for oxy-acetylene flame adjustment has been prepared particularly for guidance of new welders. The chart describes the proper appearance of the various welding flames for quick identification. Air Reduction Co.

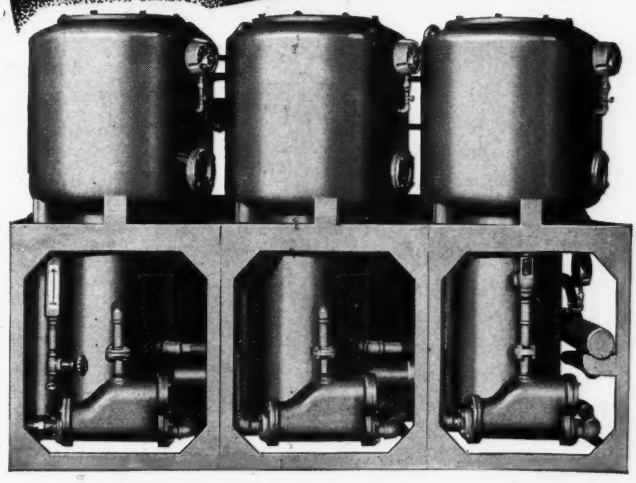
54 Dust Cleaning System—"Exidust" central vacuum cleaning systems for power stations and industrial plants are described in a new bulletin D-4.1t outlines benefits of this system for cleaning around boilers, piping, motors, switchgear, etc. Illustrations include sectional views and typical installation layouts. Allen Billmyre Co.

55 Reprinting Drawings and Charts—Handsomely illustrated catalog describes the Directo process for making quick copies of drawings, letters, data sheets, charts, etc. Directo black on white prints are easy to read; have many uses in engineering offices. Eugene Dietzgen Co.

56 Welding Electrodes—Callite Bulletin No. 154, just issued, describes the application of Callite tungsten electrodes by atomic-hydrogen, helium and argon arc welding and gives complete data on the Callite tungsten electrodes available—their physical properties — dimensions and current range in amperes. Users of welding electrodes will find this bulletin extremely interesting and informative. Callite Tungsten Corp.

57 Data Book on Welding Fittings— As much a text book as a catalog, 216-page presentation gives a wealth of information on welding fittings and forged steel flanges. Contains engineering data that will prove invaluable to the man who purchases, designs or specifies piping fittings and flanges in carbon and alloy steels. Taylor Forge & Pipe Works.

6 EFFECT EFFICIENCY with only 3 EFFECTS!



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provide an abundant supply of absolutely pure water with a saving of half the fuel necessary to get the same results by means of conventional distillation equipment.

And that is important to you if you are the man whose job it will be to provide ample, low cost supplies of absolutely pure water for power production—for industrial processing—or for human consumption.

Investigate Henszey Distillation Systems now . . . be ready with the answers as the problems arise.

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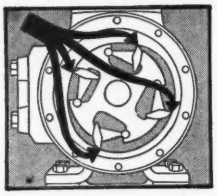
DISTILLATION SYSTEMS

Continuous Blowdown • Heat Exchangers • Boiler Feed Regulators

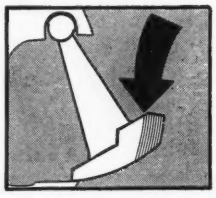
Feed Water Meters • Flow Indicators • Proportioning Valves

BLACKMER
• ROTARY •
PUMPS
are dependable EVEN WHEN OLD
that's because they are
SELF-ADJUSTING FOR WEAR!

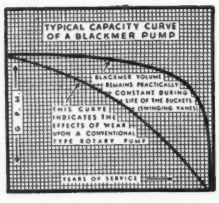
Like this—All of the wear is confined to the tips of the buckets, which automatically swing out farther, and take up the wear.



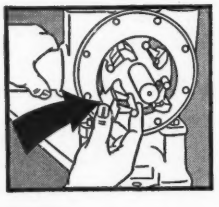
This much of a bucket can wear away without causing appreciable drop in capacity. On many jobs this means 10 years' service.



As the Curve shows, the capacity remains normal, no drop due to internal wear, until the buckets (swinging vanes) are entirely worn out.



At last when the buckets do wear out—they are replaced in 20 minutes and the pump is restored to normal capacity.



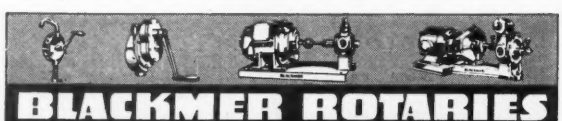
POWER PUMPS
5 to 750 GPM. Pressures to 300 psi.

HAND PUMPS
7 to 25 GPM. 54 Models.

For handling liquids varying from naphtha to asphalt, temperatures to 600° F.

Ask for Bulletin No. 304. It shows how these units cut pumping costs.

Write Blackmer Pump Company, 2011 Century Avenue Grand Rapids 9, Michigan



limitations on thickness and size as to permit increases in production molds up to ten times former capacities.

Illustrating how rapidly the array of chemical substances is growing under intensive research, there was a display of derivatives from coal by a leader in that particular field. Four years ago, at the 17th Exposition of Chemical Industries, this exhibitor displayed a list of thirty-four chemicals from coal, called "orphans" because though their chemical and physical properties were known, many of them had no then known value. Today many of these products are serving useful commercial purposes. In the meantime, however, the list of available derivatives has grown from thirty-four to more than two hundred. While the list of new materials is growing, on the other hand, some of the older and more familiar materials are coming into new uses.

Also in the line of new materials was an exhibit of a corrosion resistant plastic having a structural basis of woven glass fibres. A new development in another field is a line of filtering media fabricated of micro-porous porcelain, for which exceedingly accurate control of the pores is claimed.

Engineers to Discuss Uses of New Materials at SAE Meeting

POTENTIAL INDUSTRIAL USES of new materials, such as plastics and synthetic rubbers, and broader applications and new adaptations of established materials, such as steel, will be among featured subjects at the 1944 War Engineering-Annual Meeting of the Society of Automotive Engineers in Book-Cadillac Hotel, Detroit, January 10-14, 1944.

The preliminary program according to SAE Secretary and General Manager John A. C. Warner, provides for one entire session to be devoted to discussion of wartime development in steels and their possible future uses, and to the wartime and post-war utilization of aluminum, magnesium, synthetic rubbers, and plastics. Papers to be presented by experts in various materials fields will reveal to automotive engineers the potentialities of new materials, and of adaptations of old, in post-war motor vehicle design and manufacture.

Bureau of Mines' Fuel Efficiency Program

NEARLY 4,000 ENGINEERS have volunteered for service in behalf of the Bureau of Mines' fuel efficiency program, according to a recent announcement. Designed to minimize wasteful practices in the use of coal, coke, wood, petroleum and gas as a part of the Government's critical resources conservation campaign, the program is being organized by a recently appointed National Fuel Efficiency Council with the cooperation of the Bureau of Mines.

G. E. Forms Credit Corporation

THE FORMATION of the General Electric Credit Corp., an investment company organized under the New York State Banking Law, has been announced by the General Electric Co. The new organization will broaden the scope of activities carried on since 1933 by the General Electric Contracts Corp., and will include the business of the latter company which was principally financing the sale of consumer goods.

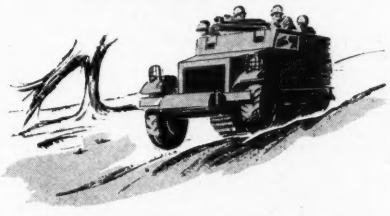
Management of the new company will be the same as that of the General Electric Contracts Corp. of which G. F. Mosher is president. The main office of the new corporation will be at 570 Lexington Ave., New York City, and branches will be operated in other principal cities.

The immediate function of the new investment company will be to provide financing for war construction and production work in connection with contracts which involve the use of products of General Electric and its associated companies, or parts produced by others for incorporation in such war products. Many of these smaller companies, Mr. Mosher declares, need more capital to handle war contracts than they required in peacetime and find some difficulty in obtaining credit. The new company will have the advantage of General Electric's intimate knowledge of the type of war work involved in the contracts and close contact with many of the contractors. In the post-war period the new company will not only provide financing for the purchase of consumer goods, but will also furnish increasing assistance in the purchase of other products of the company.

The General Electric Contracts Corp. has been engaged in financing the sale of General Electric products, particularly electrical appliances. Although such activity has naturally been sharply curtailed by the war and the consequent conversion of General Electric to all-out war production, it is intended that this business will be carried on by the new company. It is expected that such business will assume even greater proportions after the war.

On the Job for Victory

YESTERDAY



AND TODAY

Masoneilan controls and regulators have served industry faithfully since 1882. And are now serving war industries in America and the United Nations . . . well.

Having seen history repeat itself many times, Mason-Neilan was again ready, when this war started, to supply industries with automatic controls and regulators . . . each with the built-in quality characteristics that assure dependable, accurate performance and long life.

Thousands of Masoneilan controls and regulators are in use on land and sea helping to speed victory. Many more are on their way.

A portion of our production of the items illustrated is now available for other than war industries for maintenance and replacement. Catalog 71 is available. Write for a copy.

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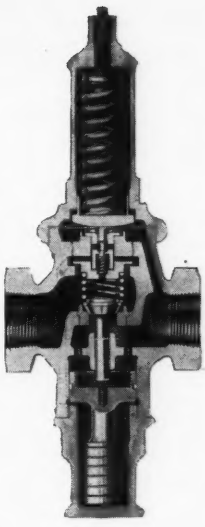
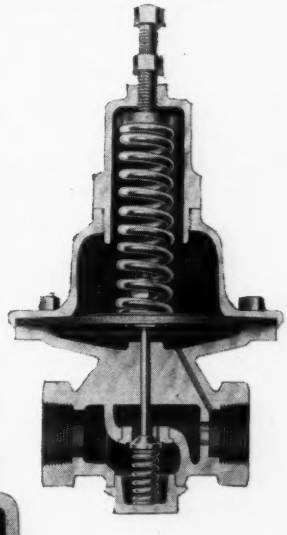


No. 11
For reducing steam pressures. Pilot operated. Sizes — bronze up to 2". Reduced pressure ranges between 5 and 225 lbs.

No. 33
For small steam or air lines, unit heaters or single radiators. Sizes up to ¾". Reduced pressure ranges between 2 and 100 lbs.



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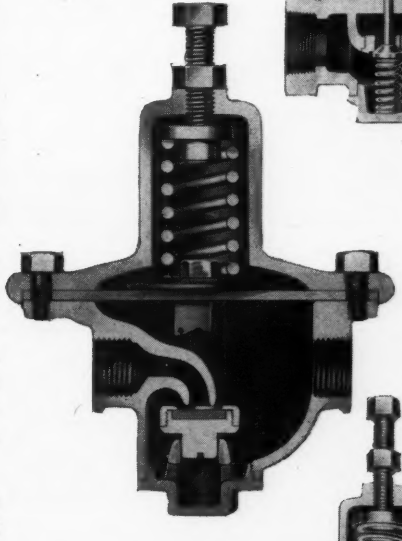
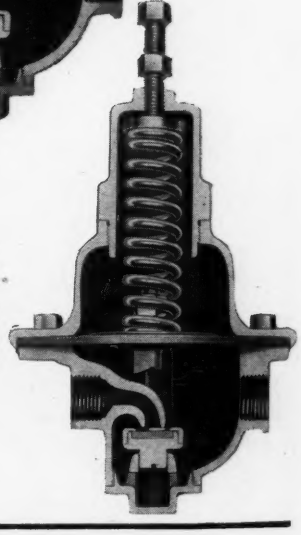
For domestic or industrial water systems. Requires no attention for years. Sizes ¼" to 2". Reduced pressure ranges between 10 and 60 lbs.





No. 414
For reducing air pressure in industrial service. Also recommended for dead end service. Sizes ¼" to 2". Reduced pressure ranges between 10 and 60 lbs.

NEW ENGINEERING BOOKS

The Chemical Background for Engine Research. Edited by R. E. Burk and Oliver Grummitt. First edition, 297 pages, 6¼ by 9¼, cloth. Published by the Interscience Publishers, Inc., 215 Fourth Ave., New York, N. Y. 1943. Price $3.50.

This very interesting book dealing with the fundamentals of combustion in internal combustion engines is not the work of any one author. It is really a compiliation of six articles or lectures, each by a different authority. In an effort to make available to research men a general picture of what was happening in closely related fields, the Western Reserve University some time ago conceived the idea of inviting distinguished scientists in the field of chemistry and closely related fields to be professors for a day. The six chapters in this book, listed as follows, represent these lectures.

I. A survey of combustion research by Dr. E. F. Fiock, Senior Physicist in the Automotive Power Plants Section of the National Bureau of Standards. II. Chemical Thermodynamics of Hydrocarbons by Dr. Frederick D. Rossini, Chief of the Section on Thermochemistry and Petroleum Chemistry at the National Bureau of Standards. III. Synthetic Methods for Hydrocarbons by Dr. F. C. Whitmore, Dean of the School of Chemistry and Physics at Pennsylvania State College. IV. Kinetics of Flame and Combustion by Dr. Gunther von Elbe with the Bureau of Mines. V. The experimental side of Combustion Research in Engines by Major Bernard Lewis, formerly Senior Physical Chemist. U. S. Bureau of Mines. VI. Some Physicochemical Aspects of Lubrication by Dr. Otto Beeck who is Associate Director of Research and head of the physics department of the Shell Laboratories in Emeryville, Cal.—A.W.K.

Applied Electronics. By the Electrical Engineering Staff at the Massachusetts Institute of Technology. First edition, 772 pages, 387 illustrations, 6 by 6 in., cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1943. Price $6.50.

A new book on electronics is no longer an unusual event but this book is different from the many others on the subject that have made their appearance in recent years. It is not only more complete than most books in the amount of material but its approach and treatment of the subject are different. As its name implies, it deals with the application of electronics but it does so in a broad, general way. It makes no attempt to describe in detail all the multitudinous electronic devices or processes that have been developed in recent years but it does provide the reader with the basic facts regarding general applications of electron tubes that will enable him to understand the detailed workings of any particular electronic device or process. In other words, a great deal of space is given to the discussion of vacuum tube amplifiers, and of vacuum tube oscillators, modulators and rectifiers but no space is wasted in needlessly describing a dozen or more amplifier or rectifier applications for different purposes, all of which fundamentally employ the same principles.

There is a good reason why this book is different from the average book on electronics and that is because it was written not by one man but a group of men. It is a part of the Principles of Electrical Engineering Series of the Massachusetts Institute of Technology and like its companion volumes[1] was prepared by members of the electrical engineering staff of that institution. The electrical engineering staff of M.I.T. has for some years been engaged in an extensive program of revising as a unit practically its entire presentation of the basic technological principles of electrical engineering. This volume is one of a series covering this revised presentation.

The book is designed for those who need the principles of electronics for problems in power, communications, control, measurement or other phases of electrical engineering. It is intended as a first course but the book assumes a certain amount of background knowledge in electrical engineering. For those engineers with little knowledge of electronics, it presents an understandable discussion, starting from elementary facts and principles.

The first three chapters give a working knowledge of the physical phenomena involved in electronic conduction. These are followed by two chapters offering an explanation of the ways in which these phenomena combine to determine the characteristics

Make Your Power Plant Building Dollars Buy Leakproof, Long-Lasting Construction . . .

Ask for a Connery Bid on those future Stacks or Breechings

WE take pardonable pride in the fact that 100% of Connery output is going to war production projects. And we feel certain that the many plants using (and planning to use) Connery's Improved Expansion Stiffened Construction for stacks, breechings, ducts, etc., won't mind if we give our best to "our first customer," Uncle Sam.

As government priority construction slackens, however, we will be in a position to offer old and new customers specific help on their problems of power plant construction.

CONNERY CONSTRUCTION CO.
Second and Luzerne Sts. Philadelphia, Pa.

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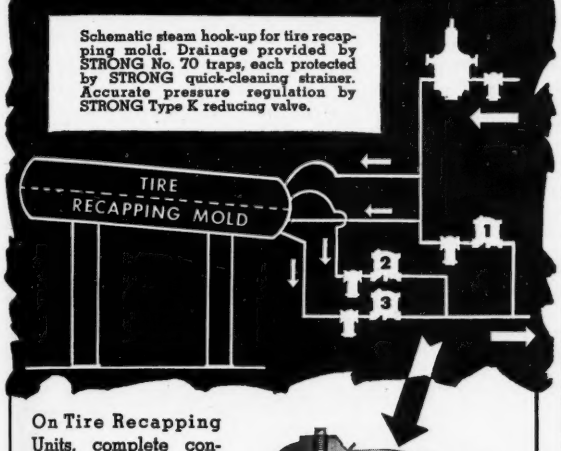
EXPANSION STIFFENED
CONNERY CONSTRUCTION

STEAM WORKS HARDER

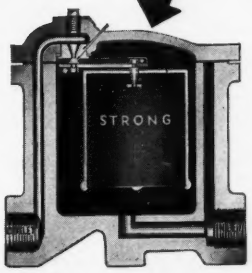
with the RIGHT TRAPS in the RIGHT PLACES

Schematic steam hook-up for tire recapping mold. Drainage provided by STRONG No. 70 traps, each protected by STRONG quick-cleaning strainer. Accurate pressure regulation by STRONG Type K reducing valve.



On Tire Recapping Units, complete condensate drainage is needed to assure the correct amount of heat at the mold. Three STRONG inverted bucket traps drain the (1) supply line (2) upper mold (3) lower mold.

The condensate rate is low, therefore, the patented STRONG anti-balancing device is valuable in preventing the "dribbling" which causes excessive wear. Strainers ahead of each trap prevent scale and dirt from interfering with operation.



STRONG 70 Series Trap Semi-Steel—for saturated steam to 150 p. s. i. working pressure.

• • •

Completeness of the STRONG lines enables us to recommend exactly the type and size you need—open or inverted bucket, closed float, float-and-thermostatic (blast), etc.—forged, fabricated, (welded), cast and semi-steel construction. Send your problems to Strong, Carlisle & Hammond Company, Cleveland, Ohio.

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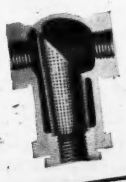
Reducing Valves

Strainers



Open Bucket Traps

PE 343

STRONG

STEAM SPECIALTIES

Are You Equipped to Hold Your Job?—to Get a New One?

The men who are keeping their jobs today—who are not feeling the whip of competition—are those who have kept one jump ahead of their jobs. They are the men who are equipped with a thorough-going and growing knowledge of the business they are in.

It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

How about you? Do you know how quickly knowledge will pile up—how quickly you will become more valuable—if you spend a few minutes a day, regularly, studying sound books like the McGraw-Hill Library of Power Plant Practice? Do you know how easily it can be managed, paying only a few cents a day, while you use the books?

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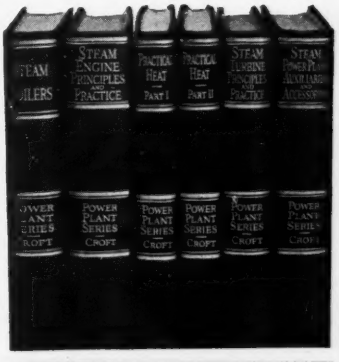
(6 volumes—2,477 pages, 2,404 illustrations)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and limitations of some of the more important electron tubes. The remainder of the book discusses applications common to the various branches of electrical engineering, of electron tube circuits in which the tube is associated with other circuit elements to form a working system such as a rectified power supply, an amplifier, or an oscillator.

Throughout the viewpoint is that of the engineer. Physical processes are treated in detail as a basis for a thorough understanding of the characteristics, ratings and applicability of electronic devices. Of particular interest is the inclusion of up-to-date material on electron ballistics, electron optics, thermionic emission, limitation of current by space charge and the electrokinetic behavior of gases.

The more important electron tubes, both vacuum and gas-filled types, are presented comprehensively with full discussion of principles. Special tubes such as cathode-ray oscillographs, electron multipliers, electron microscopes, television tubes, ultra-high frequency tubes, phototubes, ignitrons, strobotrons, etc., are included.

The principles of circuit design involved in the utilization of both the linear and masslinear properties of electron tubes are stressed and most of the functional methods by which electronics is employed in engineering are included.

Like its two companion volumes which deal with the fundamentals of the electric and magnetic circuit, this book is a welcome addition to the literature. There is a need for a book of this kind discussing the broad, general application of electron tubes and electrical engineers confronted with the problem of applying electronics in industrial processes should find it particularly valuable.—A. W. K.

[1]See Reviews. Electric Circuits—p. 132 October 1941. Magnetic Circuits and Transformers, p. 176, November 1943.

Circuit Analysis of A-C Power Systems. Volume One. By Edith Clarke. First Edition. 540 pages, 5½ by 8½ in., cloth. John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1943. Price $6.00.

Among the important problems of the transmission engineer are those which have to do with the magnitudes and distribution of currents and voltages during normal and abnormal operating conditions. Some of these problems are concerned with steady state conditions while others involve fault conditions, lightning disturbances and short circuits. All such problems are necessarily complex.

This book by Edith Clarke of the General Electric Co. deals with the analysis and solution of these problems. It was written to help the power transmission engineer solve some of his problems, and if anything can help him, this book can. Miss Clarke presents the methods of analysis as simply as they possibly can be presented. As she points out in the introduction, the problems of the power transmission engineer at any given time may be divided roughly into three classes: 1. Those that can be solved easily by well-known analytical methods. 2. Problems that can be solved analytically but where the time and labor are excessive. 3. Problems for which there is no known analytic method of evaluating all the various factors involved.

The application of the method of symmetrical components to the solution of power system problems during unbalanced conditions within a few years moved a long list of problems from Classes 2 and 3 into Class 1. Since many of the problems encountered in practice deal with systems during unbalanced conditions where the use of symmetrical and related components are of material help to the engineer, the greater part of Miss Clarke's book is devoted to these components and their applications. Tables and charts are also given, however, to assist in the solution of system conditions during normal, balanced operation.

The methods of analysis given, embody the accumulated results of long study and many years of experience. They enable accurate answers to be obtained to many problems that, not long ago, were considered incapable of solution.

Those with limited background in this field of analysis will like the author's clear approach to the subject. In an endeavor to simplify the application of the method of symmetrical components to unbalanced power systems, those concepts necessary for its application but not an integral part of the method itself, are discussed in the first chapter. In this chapter the author reviews vectors, complex quantities, operators, vector representation of sinusoidal quantities, per cent and per unit quantities, components, impedance networkers, methods of deriving equivalent circuits, etc.

Mathematically, the book is not difficult; except for an occasional in-

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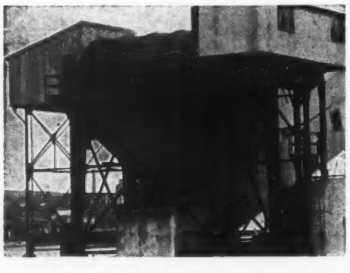

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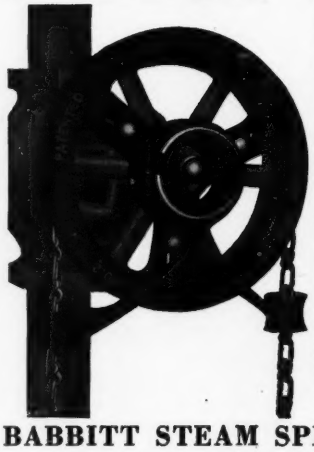

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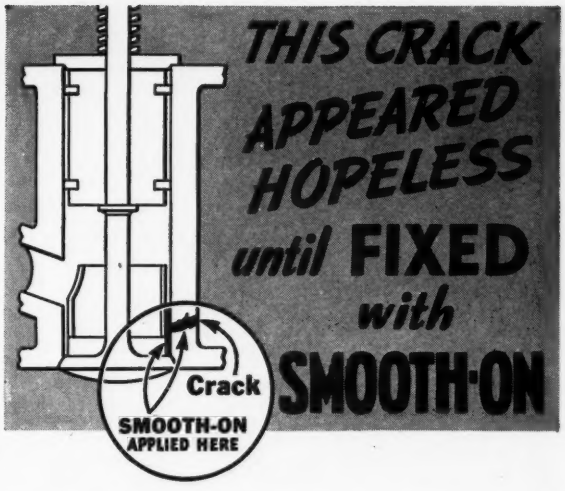

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tegral or differential equation, introduced for a better understanding of the fundamental principles involved, a knowledge of the elementary principles of alternating currents, algebra, plane geometry, trigonometry and familiarity with electrical equipment are the only prerequisites for an understanding of the book.

It will be noted that this is Volume I. This deals specifically with symmetrical and related components. The second volume now in preparation will give additional characteristics of synchronous machines, equivalent circuits for types of transformers not included in Volume I.

Aside from the value of this book to the profession, it is of particular interest because it was written by a woman. There are few women (and not many men) in the world who could write a highly technical work of this kind. Miss Clarke, a native of Maryland, was graduated from Vassar College in 1908. She studied at the University of Wisconsin in 1911 and 1912, and later at Massachusetts Institute of Technology which gave her the degree of Master of Science in Electrical Engineering in 1919. She was connected with the Engineering Departments of the American Telegraph and Telephone Co. from 1912 to 1918. In 1919 she came to Schenectady and took charge of the calculations in the General Electric turbine division. The college year 1921-1922 she spent in Turkey as professor of physics at Istanbul Women's College, but then she returned to Schenectady, joining the Central Station Engineering Division. She has specialized in the study of power transmission for many years and has presented a number of important papers before the American Institute of Electrical Engineers.—A.W.K.

Reference Data for Radio Engineers. First edition. 200 pages, 5¾ by 8½ in., cloth. Published by the Federal Telephone and Radio Corp., 67 Broad St., New York, N. Y., 1943. Price $1.00.

While this little volume of reference data, as its name implies, is intended for radio engineers, it will be found equally useful to electrical men engaged in power and industrial plants, particularly in these days of industrial electronics. It contains a considerable amount of electronic data that is equally useful to the industrial and radio engineer alike and in addition, the general engineering and mathematical data is of value to all engineers. An idea of what the book contains may be had from the following list of its contents: 1. General engineering tables. 2. Engineering and material data. 3. Audio and radio design—general. 4. Rectifiers. 5. Vacuum tubes and amplifiers. 6. Telephone transmission. 7. Radio frequency transmission lines. 8. Radio propagation and antennas. 9. Noise and noise measurement. 10. Nonsinusoidal waveforms. 11. Dimensional expressions. 12. Greek alphabet. 13. Mathematical formulas and general information. 14. Mathematical tables.

All the material is presented in a concise, practical form and the book includes more than 175 charts and tables. As an example of the kind of data the book contains may be mentioned the table and chart giving the characteristics of thermocouples; the temperature chart of heated metals showing the color of iron and steel at various temperatures, the magnetic transformations, etc.; the table showing the trade names of plastics; table giving the physical constants of various metals; data on insulating materials; machine screw data; world temperatures; tables of world precipitation, etc.

Bound in green cloth it is a useful little volume and the price is very reasonable.—A. W. K.

Allied's RF Resonance and Coil Winding Calculator. Allied Radio Corp., 833 West Jackson Blvd., Chicago 7, Ill. Price 25 cents.

This is a new slide-rule type of rapid calculator permitting the quick and accurate determination of inductance, capacitance, and frequency components of series or parallel tuned RF circuits as well as inductance, turns-per-inch, wire type, wire size, coil diameter and coil length for single layer-wound solonoid type RF coils. All values, in either case, are found with a single setting of the slide and are accurate to within approximately 1 per cent for coils ranging from ½-in. to 5½-in. in diam. and ¼-in. to 10 in. in length. All possible combinations within these limits are shown. Wire types and sizes include 11 to 35-gage plain enamel, 11 to 36-gage S.S.C., D.S.C., and S.C.C., and 12 to 36-gage D.C.C. The rule is also engineered to indicate: turns-per-inch from 10 to 160; inductance from 0.1 to 15 microhenrys; capacitance from 3 to 1,000 micromicrofarads; frequencies from 400 kilocycles to 150 megacycles with equivalent wavelengths in meters. The speed and accuracy with which these factors can be related provide the engineer, maintenance man, service man, amateur, student, instructor, and experimenter with an invaluable tool.—A. W. K.

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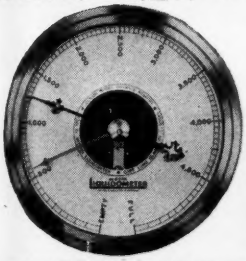

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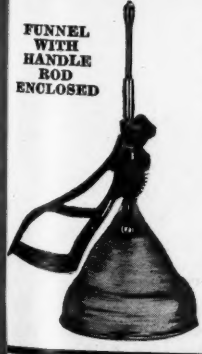

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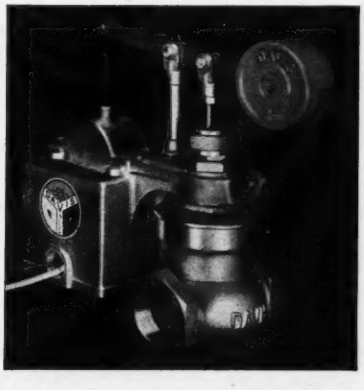

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Power Plant Construction News

Calif., Los Angeles—Levine Cooperage Co., 156 South Anderson St., manufacturer of barrels, boxes, etc., plans boiler house, about 31 x 60 ft, at new plant at 5400 South Soto St. Entire project will comprise several one-story buildings, with facilities for large output. Electric power equipment will be installed. Cost estimated close to $100,000, with machinery. Work will be placed under way soon. Ted R. Cooper Co., 1031 South Broadway, Los Angeles, is architect.

Calif., Los Angeles—Taylor Milling Corp., 1520 San Fernando Rd., plans installation of electric power equipment in new one-story addition, about 100 x 100 ft, to commercial fertilizer plant at 3345 Medford St., reported to cost over $70,000, with machinery. Merrill W. Baird, 947 North Isabel St., Glendale, Calif., is architect.

Conn., West Haven — Armstrong Rubber Co., Inc., 475 Elm St., manufacturer of automobile tires, tubes, etc., plans installation of electric power equipment in new three-story and basement mill addition, about 110 x 300 ft, reported to cost over $160,000, with machinery. Work on superstructure will begin soon. Fletcher-Thompson, Inc., 211 State St., Bridgeport, Conn., is architect and engineer.

Fla., Fort Myers—Water Department has plans under way for four new pumping stations for water system, with installation to include five motor-driven pumping units of large capacity, with controls and auxiliary equipment. Also will make improvements in present pumping stations and facilities. Entire project reported to cost over $300,000. Russell & Axon, 4903 Delmar Blvd., St. Louis, Mo., and Jacksonville, Fla., are consulting engineers.

Fla., Pensacola—Gulf Power Co., Pensacola, has authorized new steam-generating station in Olive district, and has awarded contract for building to Hardaway Contracting Co., Columbus, Ga. Equipment awards are being made separately. Work will be placed under way at once. No estimate of cost announced.

Fla., St. Petersburg—Florida Power Co., has approved plans for new addition to steam-electric generating station, about 50 x 90 ft, equivalent to three-story in height, estimated to cost about $200,000, with equipment. It is understood that project has a priority rating, with work scheduled to begin at early date. Contract for building construction has been let to Clarson & Mills Co., St. Petersburg.

Ill., Alton—International Harvester Co., 180 North Michigan Ave., Chicago, Ill., has acquired tract of about 375 acres of land fronting on Mississippi River, vicinity of Alton, as site for new plant for production of agricultural and farm machinery, to be carried out as a postwar project. It will comprise large group of one-story buildings for machine shops, forge shop, foundry, assembling works and other departments. Electric power equipment will be installed. A power plant is planned with facilities for central-heating service. Entire project reported to cost over $2,500,000.

Ind., Garrett — Garrett Municipal Utilities plan expansion and improvements in municipal steam-electric generating station as a postwar project, including installation of additional equipment for increased capacity. Estimated cost not announced.

Ind., Indianapolis — Consolidated Rubber Laboratories, Inc., 399 Division St., manufacturer of rubber products, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire, with loss reported close to $130,000. It is understood that a priority rating is being secured.

Ind., Richmond—Board of Trustees, Richmond State Hospital, plans extensions and improvements in power house at institution as a postwar project, with installation of additional equipment for increased output. Cost reported about $75,000. P. D. Williams, is superintendent.

Iowa, Bettendorf — Ornance Steel Foundry Co., manufacturer of heavy castings for military tanks, artillery units, etc., plans installation of electric power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire, with loss reported over $200,000. Project will have a priority rating.

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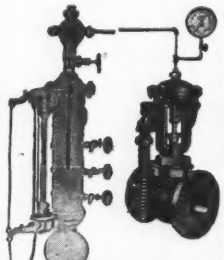

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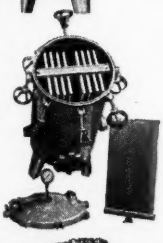

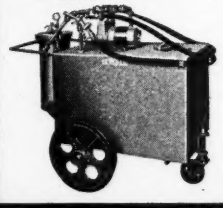

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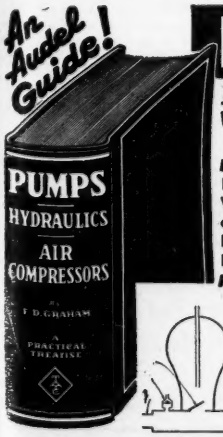

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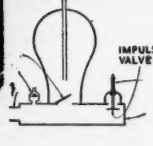

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Md., Fairfield—Bethlehem-Fairfield Shipyard, Inc., an interest of Bethlehem Steel Co., Shipbuilding Division, plans installation of electric power equipment in new one-story machine shop, on which work will begin soon. Cost reported over $80,000.

Mich., Lansing—Olds Motor Works, Division of General Motors Corp., Lansing, now in production for axle forgings for heavy-duty military trucks and kindred products, plans installation of electric power equipment in three new one-story buildings for general expansion. Work is scheduled to begin at once. Cost reported in excess of $400,000, with machinery.

Mich., Muskegon—Continental Aviation & Engineering Corp., 12801 East Jefferson Ave., Detroit, Mich., manufacturer of aircraft engines, parts, etc., affiliated with Continental Motors Corp., same address, plans installation of electric power equipment in new plant at Muskegon for production for Government, comprising several large production buildings. Entire project is estimated to cost about $40,000,000, with financing in that amount provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will begin soon.

Minn., Rochester—Peoples Cooperative Power Association, 18 Sixth St., N.W., plans extensions in electrical distribution system in parts of Olmsted County, including service connections and other operating facilities. Cost estimated about $60,000. Financing has been arranged through Federal aid. Project will have a priority rating.

Miss., Gulfport—Phoenix Naval Stores, Inc., manufacturer of turpentine, rosin and kindred products, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, including extracting unit, recently destroyed by fire. Loss reported in excess of $200,000. It is understood that application is being made for a priority rating.

Mont., Glendive—Farmers' Union Service Cooperative, Inc., Glendive, Charles Schepens, secretary, plans new cold storage and refrigerating plant with locker system on local site at Kendrick and Valentine Sts., recently acquired. Initial installation will comprise about 1000 locker units. Cost reported over $60,000, with equipment.

N. Y., Gowanda—State Department of Hospitals, State Office Building, Albany, N. Y., plans new cold storage and refrigerating plant at Gowanda State Hospital, as a postwar project. Fund of $360,000 has been authorized by State Postwar Public Works Planning Commission, Albany, for this and new assembly hall at institution.

Ohio—Lake City Malleable Co., Inc., 5000 Lakeside Ave., Cleveland, manufacturer of malleable iron castings, etc., plans installation of electric power equipment in new plant in Ashtabula County, exact location not yet announced, for production for Government. It will comprise several one-story buildings, with power house and auxiliary structures, estimated to cost about $3,360,000. Financing will be provided by Defense Plant Corp., Washington, D. C., Federal agency, which will retain title to property. Work will begin soon.

Okla., Miami—B. F. Goodrich Co., Inc., Akron, Ohio, manufacturer of automobile tires, tubes, etc., plans power house at proposed new mill in vicinity of Miami, where tract of land has been purchased. Plant will be used for manufacture of tires from synthetic rubber, and will comprise a number of buildings, equipped for large output. Electric power equipment will be installed. Entire project is reported to cost over $1,500,000.

Texas, Eagle Pass—Central Power & Light Co., Corpus Christi, is reported planning a postwar extension and improvement program at power plant at Eagle Pass, as well as ice and cold storage plants and other utilities at that place and at Edinburg, with a new frozen food locker plant to be located in latter area. Entire project is estimated to cost close to $100,000.

Texas, Mineola — Wood County Electric Cooperative, Quitman, Texas, plans new cold storage and refrigerating plant with locker system, at Mineola, where site has been selected. Cost reported close to $45,000, with equipment. A similar plant is planned at Winnsboro, to cost about like amount. It is understood that priority ratings are being secured.

Wis., Marshfield—Water and Light Dept., Edward F. Kipp, superintendent, is considering new pumping plant for municipal waterworks system, with motor-driven pumping units, controls and auxiliary equipment. No estimate of cost announced.

Wash., Toppenish—Yakima Reservation District, Yakima, Wash., Donald M. Carr, president, has plans maturing for Pumping Station No. 2 at Toppenish, Wapato Project, with installation of motor-driven pumping units, controls, power lines and other facilities. No estimate of cost announced. Project has been granted a priority rating by WPB, and is scheduled for completion next spring.

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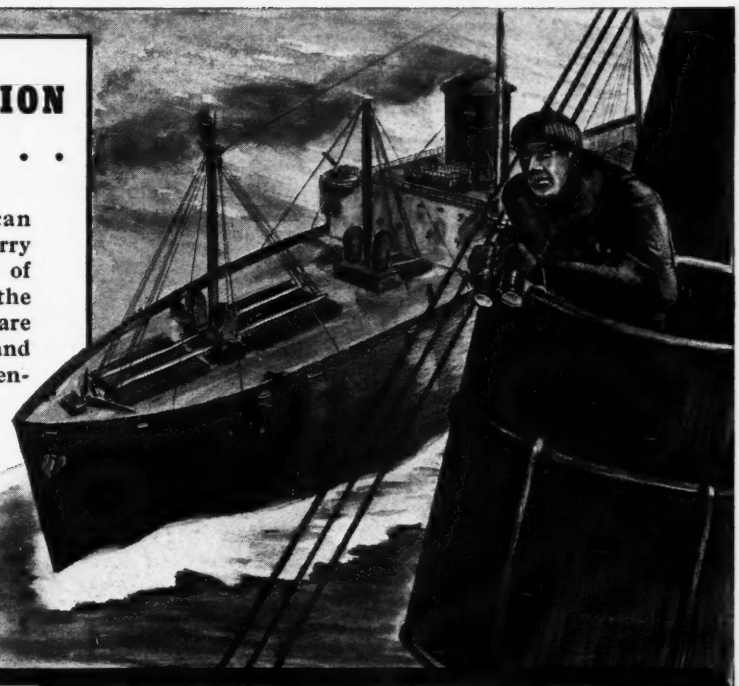

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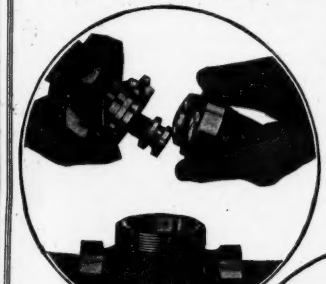

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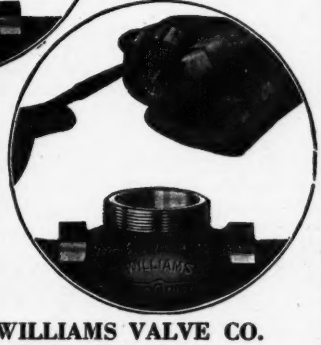

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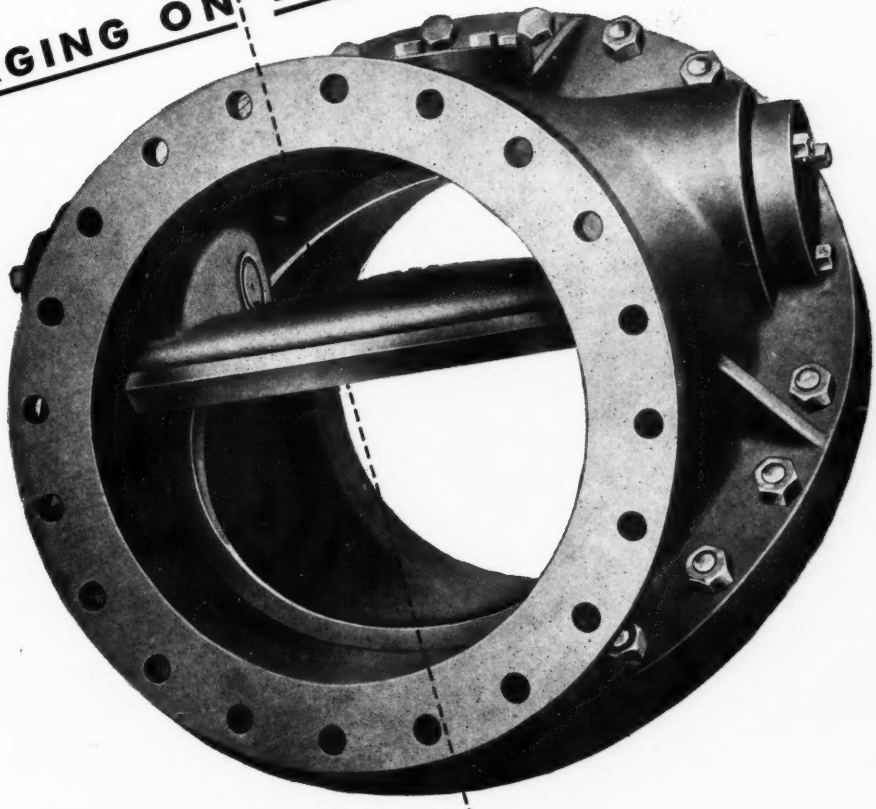

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